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DYNAMO-ELECTRIC MACHINES.

In nearly all the articles which have hitherto appeared in the various journals connected with the subject of electric lighting, the least attention has apparently been paid to the most important part of an electric lighting installation, *i.e.*, the dynamo-electric machine. The various methods of connecting up lamps, arc and incandescent, the best and most economical way of employing them, and all other details relating to this portion of any system, have been fully described and dilated upon; but the mode of use and the best construction of a dynamo-electric machine, for any particular method of utilising the electric current for the production of light, have not had the attention the matter deserves. We shall limit ourselves for the present to the consideration of one point only in this direction, and inquire whether it is more desirable to employ auto-exciting machines, or those whose field-magnets receive their current from a separate source. In the first instance we have the bobbin, electro-magnets, and external circuit of lamps, all in one direct circuit, and all dependent one upon the other. In the second case the bobbin and external circuit are entirely contained within themselves, the electro-magnets forming part of the circuit of the separate excitor. Taking the first kind of machine, and revolving it at, say, 1,000 turns per minute, it gives us through a definite external resistance a certain strength of magnetism, and a stated intensity of current. These will continue constant as long as our speed and external resistance remain the same; but directly our external circuit varies in resistance, then the magnetism and current produced are immediately affected, and the machine tends either to pull up or to run away in accordance with the diminution or increase of resistance. Therefore, at times when we require a greater strength of current to overcome our external resistance, we must necessarily be content with just the opposite.

When the electro-magnets of such machines are once wound with wire having a certain number of convolutions, and of a given resistance, we cannot alter their condition for the varying effects we may wish to produce. A machine of this class, then, may be much more efficient for one operation than for another, and the percentage of the total horse-power expended in a circuit, for magnetising the electro-magnets, forms an important element in their construction; and we doubt very much whether, when manufacturing dynamo-electric machines for certain purposes, the best form of electro-magnet, size of wire, number of convolutions, &c., are sufficiently taken into account.

Machines which have their field-magnets excited from a source independent of that which produces the light have considerable advantages over those we have been speaking of, and, as one small excitor may be made to produce the current for magnetising the field-magnets of several light-giving machines at once, we think that this method of working will shortly be much more extensively adopted than it is at present. The magnetism could be rendered constant or varied to suit circumstances, and the current for producing the light would remain much steadier. If the external resistance of a circuit increased the speed of the machine would slightly increase, and as the magnetism is derived from another and approximately constant source, we should develop higher electromotive force to overcome our increased external resistance. We need not concern ourselves so much with the size of wire and the convolutions we should put on our electro-magnets when using a separate excitor, as there is no external variation of resistance to affect our magnetism. We do not mean to say that this is a matter of indifference, but that it does not play such an important part in the construction of a machine as it does when the wires of the field-magnets form a part of the whole circuit. The nearest approach we can have to a separate excitor is to employ our electro-magnets in a shunt circuit, but even then our magnetism varies with any change in the resistance of the lamp. The Brush machine is a good example of this system of using dynamo-electric machines, but with this addition, that the field-magnets are wound with both thick and thin wire, the one in the main and the other in the derived circuit, and both go to produce the necessary magnetism. One of the great drawbacks of the first mentioned and simplest method of arranging a circuit is the inability of the machine to do a small amount of work. For instance, if we are possessed of a machine which will keep, say, sixty incandescent lamps in operation, we should fail entirely to work ten, as the external resistance in the latter case is so comparatively large that we could not produce sufficient current (owing to the low electromotive force produced at the start from residual magnetism) to bring up our magnetism to the necessary point. We might, of course, work ten if we placed artificial resistances in the places of the fifty extinguished lamps; but then we waste 5-6ths of our power. If a moderate magnetic field could be provided and kept constant in a machine having its bobbin, electro-magnets, and external circuit in one, we should then get over the above difficulty. It does not appear difficult to imagine that a combination of permanent and electro-magnets will some day be employed to produce a greater electromotive force at the starting of the machine. The original Gramme machines of the old type had three bobbins, one used exclusively for magnetising the field-magnets, the remaining two for producing the light-giving current. Such an arrangement as regards the magnetising bobbin, one would think, might be carried out with advantage even now, as both the magnetising and taking-off bobbins might be smaller than those at present in use for producing given results. Now that lighting by incandescence seems to be in the ascendency, and as it is so necessary that the current for these slender carbon filaments should be steady, we think that more attention should be devoted to the question of dynamo-electric machines, and to the best mode of arranging their parts; for it follows that if inventors dispose of their lamps and minor accessories to such advantage as many have hitherto done, a much wider and more profitable field is opened up in perfecting the first and most important factor involved in electric lighting.

THE BAUDOT TELEGRAPH.

(Fourth Article.) 374

THE DISTRIBUTOR.—In theory the distributor is only subjected to the condition of connecting the manipulator to the corresponding receiver every moment. This condition will be fulfilled, if at the starting point and destination there

H_1 Brushes.
H_2 ,,
B Battery connected to relays.
E Earth.
b Local battery.
C Various contacts.
c Contacts in connection with earth during reception.
R_1 Reception row.
R_2 Transmission row.
F_1 Local printing tongues.
F_2 Transmission tongues.
K Commutator.
M Relay bobbins.
L Line.
b_1 Local battery.
B_1 Negative pole of line battery
B_2 Positive ,, ,,

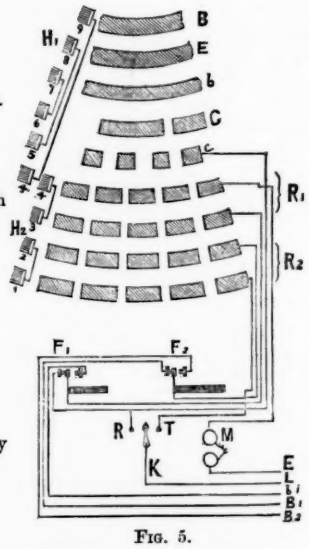


FIG. 5.

are two pieces of mechanism united by the line and bearing similar divisions, which are traversed by rubbers moving in synchronism.

But in reality, the distributor is required to perform various accessory functions; instead of the original simplicity of a single row of contacts, distributed round the circumference, we find here a slight complication.

M. Baudot has arranged nine rows, to which correspond as many rubbers; and for one of the series there are two consecutive rubbers for a purpose to be explained hereafter. We shall describe the series of the nine rows of contacts (which form concentric circles), proceeding from the outer one to the centre.

The circumference of the distributor is divided into seven sectors, six of which are employed in the six-fold transmissions, according to the principle of multiple telegraphy, the seventh serving to correct the synchronism. This latter occupies an angle of about 40° on the circumference. We will first examine the sectors of transmission and reception, and it will be sufficient to study one only. Fig. 5 shows the order of the contacts traversed by the rubber and the principal communications.

The two first rows, called rows of transmission, are thus made up: the first occupies the whole length of the sector, and is connected with the terminal T of the commutator, which has been already mentioned. It will be remembered that this part of the apparatus, placed under the hand of the transmitter, enables him to place himself in readiness for transmitting or receiving, according to whether the handle is placed at the terminal R, or the terminal T. The arrangement above indicated puts the line in communication with the two rubbers, 1 and 2. The second row of contacts traversed by the rubber, No. 2, consists of five divisions, connected respectively with the five transmitting armatures of the manipulator. We are already acquainted with the function of these armatures which are sometimes in contact with the rest stop, and sometimes with the action stop, thus producing a negative or positive emission; the figure will complete the explanation.

The rows 3 and 4, traversed by the corresponding rubbers, are called reception rows. The zone No. 3, formed like zone No. 2, of five contacts, is in connection with the five armatures of the manipulator before described, which serve to insure the local impression. The method of communication is the same as for zone 2, but with different armatures.

Zone No. 4 is also formed of five contacts in communication with the coils of the receiving electro-magnets the other extremities of which are connected to earth. It is easy to understand that the simultaneous passage of the rubbers 3 and 4 over the corresponding rows will insure the local impression directed by the special armature of the manipulator.

The fourth row is traversed by a supplementary rubber, 4^1, slightly in advance (about one contact and a half) of rubber 4. This rubber, 4^1, connected with rubber No. 9, sends a negative current into the coils of the receivers a little before they are reached by the principal current (of reception or transmission). The effect of this accessory current is to bring to rest all the armatures of the receivers, or in other words, to efface the preceding combination, so as to place the apparatus in readiness to show the next one.

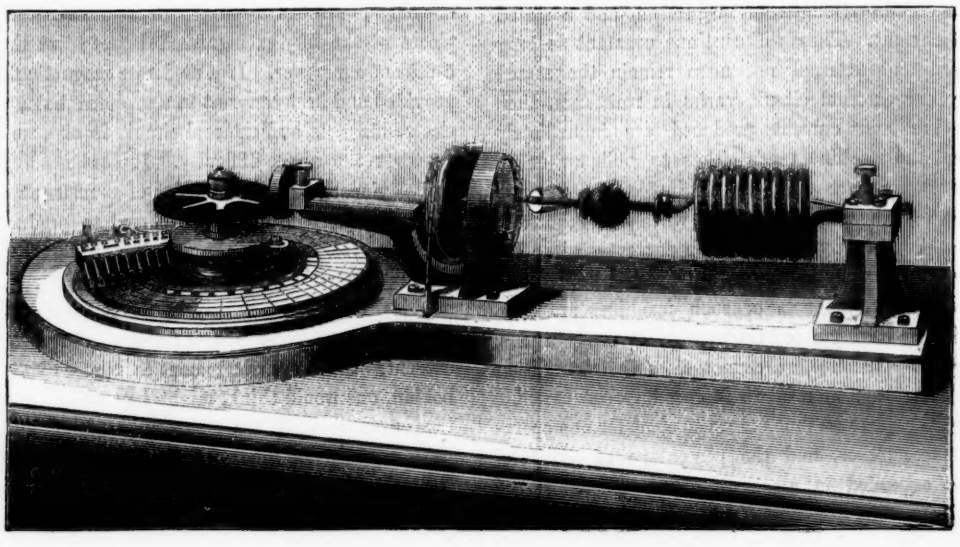


FIG. 6.

The fifth row consists of four smaller contacts, corresponding to the intervals between the contacts of the third and fourth rows, and insure the putting to earth during transmission, so as to discharge the line between each emission of the correspondent; this effect is produced by connecting rubber 5 with rubber 8.

The sixth and seventh rows serve to send a local current for various purposes. We may mention, in the first place, the working of the sounder already mentioned, which gives

the operator notice to prepare on the manipulator the combination corresponding to the signal; we shall find another function of the local current when we come to speak of the printing mechanism.

The eighth and ninth rows are described in the above analysis.

It must be observed that the different sectors are not separated by a blank interval, but by a special contact insulated from the series belonging to two consecutive sectors. This arrangement is repeated for the first four rows; it serves either for the transmission of accessory currents, or for sending to earth so as to facilitate transmission through long lines. We shall return to this subject.

Let us now indicate clearly the function of the correction sector. It is formed of a continuous contact in rows 1 and 3, and of four broken contacts in rows 3 and 4; these four rows are traversed by the rubbers which pass over the zones of the transmission and reception sectors; the required communications are established either with the earth, with a battery, or with a special electro-magnet called the correcting electro-magnet which works thus:—when the difference of speed between the two sending and receiving distributors exceeds a certain fixed quantity a current is sent, the armature is moved, and causes a corresponding displacement of the chariot disc. This result is obtained by means of a subsidiary gearing which acts upon the system of brushes independently of the general movement imparted to them by the special motor of the distributor. It is arranged that the receiving distributor shall always be in advance of the sending distributor; we see, therefore, that the correction takes place at each revolution by means of the movement of the armature of the correcting electro-magnet, then the speed is gradually lessened until the correction is only effected every five revolutions for instance; the apparatus is then well regulated.

In conclusion, it remains to describe the actual distributor as shown in fig. 6.

It consists of a circular plate of ebonite, in which are fitted the metallic contacts. Each contact is connected underneath with the conducting wires, which are collected into a box whence they extend to the terminals, the line, the batteries, and the earth.

In the centre of the plate is the stand bearing the chariots which receives the movement from the motor by means of an angular wheel. The motor may be a weight or a little water-wheel, or even a magneto-electric machine. The rubbers consist of little brushes similar to those of the Gramme machines. The transmission of the movement to the chariot disc is effected by means of a part of the apparatus forming a case having at its base a pinion connected with the subsidiary gearing. The latter allows of a corresponding displacement of the system of rubbers by means of a little rod put in motion by the armature of the correcting electro-magnet. The movement is rendered uniform by means of a fly-wheel, a regulator of speed with a plate vibrating helically, and by a friction moderator similar to that of the Hughes apparatus. The speed is regulated by the displacement of a weight along the vibrating plate.

(*To be continued.*)

ON ELECTRIC LAMPS ACTUATED BY A DERIVED CIRCUIT.

A SHORT time since we were asked by a friend several questions concerning electric lamps, in which the carbons were regulated by the current passing through a coil of fine wire, which formed a shunt to the main circuit. Our experience with the working of the Lontin lamps which were employed in 1879 for illuminating the Aldersgate Station of the Metropolitan Railway was particularly desired, and as a curious circumstance has arisen on this point, we think it will form a subject of interest to our readers. As most electricians are aware, the Lontin lamp is a clockwork regulator of the Serrin type; but its mode of action was just the reverse of this latter, and effected by means of a very ingenious modification. It had one electro-magnet only, of fine wire, which was in a derived circuit, and its duty was to lift the *lower* carbon holder with its frame, and set the clockwork moving, which would keep running as long as the armature of the electro-magnet—which was attached to the frame of the lower carbon holder—remained attracted, the carbons being thus brought together. The lamp, when in its normal condition, had its carbons slightly parted. When a current (alternating) was sent through the circuit, it took effect of course on the shunt coil only. This lifted the lower carbon into contact with the upper, and the main circuit through the carbons being thus established, the lower carbon holder and its frame fell again, forming the electric arc. Then, as the length of the arc, and therefore its resistance, increased, the shunt coil became active, lifting the lower frame and carbon, and allowing the clockwork to run, thus bringing the upper carbon slightly down until a proper length of arc was again established.

The eight lamps (two in each of four circuits) which were employed for lighting the Metropolitan Station above referred to required a considerable amount of attention during the time they were in action. Frequently if the engine increased its revolutions to a slight extent, and therefore the speed of the Lontin machine, the increase of current in the circuit would be sufficient to actuate the shunt coil, so that the clockwork ran sufficiently long to bring the carbons into actual contact, and then they often fused together. On the other hand, if the current decreased from its normal working strength the shunt coil did not come into operation until the current in the main circuit could no longer keep up the gradually increasing length of arc, and the light would therefore go out, the carbons then being again brought together, and the arc re-established. The first instance of extinction of the light had usually to be remedied by getting up to the lamps and parting the carbons by hand; the second would correct itself in a short time.

The general explanation given of the action of this lamp, and indeed of others actuated by a derived circuit, is this:—When the current goes through a lamp it divides, the major part going through the arc—it having a comparatively small resistance—and the shunt coil taking only a small amount by reason of its usually high resistance. As the length and therefore the resistance of the arc increases, more current necessarily passes through the shunt—sufficient to allow the adjusting mechanism to act—and the carbons are thus brought again within a set distance of each other. This explanation, however, is very deficient, and we therefore purpose giving the correct version of what really takes place in a derivation lamp. Let us suppose the diagram, fig. 1, to represent the lamp in question. C C', upper and

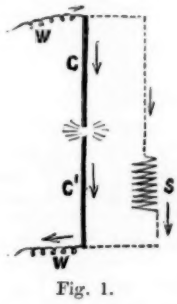


Fig. 1.

lower carbons respectively; S, the shunt coil; and W W, the leading wires.

For the sake of example we will say one lamp is burning, and that the difference of potential between its terminals is 50 volts. The resistance of the arc or main circuit shall be, say, 4, and the resistance of the shunt coil 60 ohms, and the armature of the latter is adjusted to act for a given strength of current. Now, under these conditions, we shall have:

$C = \frac{50}{4}$, = 12·5 ampères passing through the main,

and $C = \frac{50}{60}$, = 0·83 ampères in the derived circuit.

Imagine the resistance of the arc having increased to 6 ohms, we then get a current strength of only 8·3 ampères in the main circuit; but still the current flowing through the shunt is just the same if our electromotive

force has remained constant. It follows, therefore, that whatever the resistance of the arc may be, we have a constant current strength in the derived circuit (it having a constant resistance), as long as our electromotive force remains the same. The action of the shunt electro-magnet then depends upon something occasioned by the alteration of resistance in the arc, and this factor is the continual change of potential between the terminals of the lamp. It is easily understood that an increase of resistance in the arc would occasion the engine and machine to run a trifle faster, which would develop a corresponding increase of electromotive force. For instance, if the resistance of one lamp has changed from 4 to 6 ohms as in the first example, and that by this change an electromotive force has increased to 70 volts, we then get flowing through the main circuit, say, 12 ampères, or nearly the same as at first; but in the derived circuit we have 1·4 ampères, or an increase of nearly $\frac{1}{3}$ in the current strength, which would be sufficient to keep the armature of the coil attracted, and therefore the clockwork running until the carbons came in contact with each other and fused together. For although when moving towards one another, and the resistance of the arc decreasing, the tendency is to reduce the speed of the machine, yet there is not sufficient time between the commencement of the clockwork running and the carbons coming together to enable the checking action of the reduced electromotive force to take effect. The friend to whom we referred has recently been trying experiments with this kind of lamp, and he gives the result of his experience as the reverse of ours in respect to an increased current; and explains the difference by the fact that an increase of current through the arc lessens its normal resistance, and that, therefore, the extra current is drawn away from the shunt, which is kept nearly constant. We have, of course, assumed that the resistance of the shunt coil is a constant one, for, although it may slightly increase by the current heating the wire at the beginning, it soon becomes approximately stationary. We think, therefore, that we have shown in a sufficiently clear manner that the derived circuit comes into action only by an increase of potential between the terminals of the lamp, occasioned by greater electromotive force in the machine, which is in its turn attributable to an increase of resistance in the arc. It follows, then, that the difference of potential is continually varying above and occasionally below a normal value.

THE AMENDMENT OF THE LAW RELATING TO PATENTS FOR INVENTIONS.

By T. J. HANDFORD.

(*Continued from page* 338.)

WE now pass to the consideration of other important alterations proposed by Sir John Lubbock's Bill, some of which are undoubted improvements upon the existing law. Of these, the points which will most commend themselves to the notice of inventors and intending patentees are an increased length of term for the patent and a considerable reduction in the amount of the Government fees payable upon it. It is proposed to grant patents for 17 years, the fees on the application being £2 10s., and on the grant of the patent £5, and further fees being payable of £20 and £50 before the expiration of the fourth and eighth years respectively. These provisions will prove a great boon to inventors, but it is questionable whether still further concession might not advantageously be made in this direction, especially in the case of the fourth and eighth years' duties. Patentees will, however, appreciate other proposals of the Bill, viz., that in special circumstances a six months' extension of the time prescribed for the payment of these duties is to be allowed without its being necessary to apply for a special Act of Parliament for the purpose, as is the case at present. Also that the Commissioners are to have power in certain cases to extend the term of provisional protection; further, that the duration of a British patent is in no case to be affected by the expiration or earlier determination of a foreign or colonial patent of prior date for the same invention.

Having disposed of the matters of what may be termed the pecuniary consideration for the patent, and of its duration, other equally important questions remaining are—

1. Who may be a patentee? and
2. What may be patented?

The answers to both these questions, as furnished by the proposals in the Bill, will give satisfaction to both inventors and the public.

1. A patent is to be granted to inventors, or their executors, administrators, and assigns, or their attorney or agent, and to no one else.

This, in the first place, sweeps away the iniquitous system of granting patents to mere importers of inventions, who in many cases obtain the invention surreptitiously, or in fraud of the real inventor. It also enables an executor to obtain a patent for an invention which may not have been protected at the death of the inventor, whereas, according to the present system, not even the widow of a deceased inventor can obtain a patent for an invention which has been communicated to her by her late husband in his lifetime, or been found recorded among his papers after his death.

2. There is no material, if any, alteration with regard to the valid subject-matter of patents, but it is proposed that an invention shall be deemed new if it have not been published or publicly used in the United Kingdom for thirty years. Experience shows that the resuscitation of an invention which has been long buried and forgotten is frequently of as much commercial value as the conception of something absolutely new. Sound judgment, therefore, seems to be evinced in thus offering an inducement to industrial enterprise in a field rich in hidden treasures, but which hitherto has been unproductive because there was no incentive to cultivate the same; but on the contrary, whenever an invention was proved to be a success, there were always scores of detractors prepared to prove that something similar had been contained in the archives of the Patent Office for perhaps a century past, although no one was ever one whit the wiser for the so-called public knowledge until it was discovered that the unfortunate patentee had achieved success. To the same end will operate another provision of the Bill, viz., that if a patent is refused, or the application otherwise not proceeded with, the provisional specification is to be destroyed, and that when a patent is granted the provisional specification is to be preserved secret until the expiration of the patent, and then destroyed. A constant source of annoyance to patentees under the present system will thus be obviated, as although a provisional specification, wholly or partly abandoned, seldom contains sufficient information to enable its subject-matter to be practically carried into effect, yet it frequently hampers and impedes a subsequent inventor in his attempts to establish an indefeasible claim to that to which he is fairly entitled.

Under this head may also be noticed another equitable feature, viz., that a foreign or colonial patentee is not to be prejudiced in obtaining a valid British patent by the publication of his foreign or colonial specification, provided he makes application for his British patent within eighteen months of the date of his foreign or colonial patent, or of the earliest of them if there be more than one. It is manifestly a gross act of injustice to deprive a man of his just rights in Great Britain simply because a copy of the specification of a patent which he may have previously taken in the colonies or abroad happened to reach this country perhaps not twenty-four hours before he lodged his application in England.

The new Bill also makes provision for the grant of compulsory licences—a provision of questionable advantage and doubtful expediency. It further provides for the amendment of specifications, the grant of extensions of the term of a patent, and for the revocation of patents, the powers necessary for the performance of these functions being all vested in the Commissioners.

With regard to the amendment of specifications, it is proposed, and rightly so, to assimilate the English practice to the system which obtains in the United States, and allow a patentee not only to disclaim but to extend his claims, provided the new matter was originally contained on the face of his specification.

As to the prolongation of patents, the maximum extension is to be eleven years, and the privilege is not to be hampered, as is now frequently the case, by the imposition of any special conditions.

In lieu, moreover, of the costly proceeding by *scire facias* to repeal a patent, the Commissioners may revoke a patent on its being proved that it ought not to have been granted; and where a patent so revoked has been obtained in fraud of the true inventor, the Commissioners may grant the latter a patent bearing the date of the cancelled patent.

The Bill also contains provisions for dealing with infringements of patents which have given, and will give, rise to much hostile criticism.

First, it is intended to abolish certain pleas which are now admissible in actions for infringement of patents, but, as the chief of these proposals are only the natural offshoot of other regulations in the Bill to which we have already adverted, they require no particular comment. The points, however, to which we have to direct special attention under this head are the propositions that the Commissioners, or any one or more of them, may act as assessor or assessors at the request of a court or judge, and that they may try cases which might be referred to an official referee, and may act as arbitrators in matters of dispute arising out of alleged infringements. These proposals, although somewhat insidiously introduced, virtually amount to the delegation of judicial functions to the Commissioners; and, much as we deplore the drawbacks and inconveniences attending the present system of judicial procedure, we do well to pause and seriously consider whether the proposed change would not give rise to far greater evils than those it is intended to remove. In speaking thus, we do not for one moment wish to underrate the defects inherent in the existing system. To see a number of men of eminence in the scientific world enter the witness-box, take the oath that the evidence they are to give to the court touching the matters in the suit is to be the truth, the *whole* truth, and nothing but the truth, and then deliberately keep back that part of the truth which tells against their client, and fence with a hostile counsel who is seeking to extort from them that which they have pledged themselves to disclose, but which it is the interest of their client for them to conceal, is a spectacle which is, to say the least, far from edifying. One is involuntarily led to some casuistical reflections as to the difference, from a moral point of view, between *suppressio veri* and *suggestio falsi*. The proposals in the Bill, however, do not appear to touch this evil, but simply relate (taking them in their broadest sense) to the substitution of the Commissioners for the judges of the High Court of Justice, in the trying of patent actions. When, however, we remember the profound learning, the penetrating acumen, and the scrupulous integrity and undeviating impartiality of the occupants of the Bench, we may well hesitate before we consent to give up that which has borne the test of so many years, notwithstanding all its imperfections, for a system of the working of which we can predicate nothing with certainty, except that it is not likely soon to inspire that general confidence which men of every rank and class repose in the ability and rectitude of the judges of the High Court of Judicature, as at present constituted.

There is one other point to which we find no reference in Sir John Lubbock's Bill, but which should have a place in any complete system of legislation relating to patents. We allude to the necessity for the imposition of some test or examination in order to qualify persons to practise as patent agents. The space at our disposal will not admit of our doing justice to this important, but exceedingly delicate, branch of the subject. We must, therefore, content ourselves with thus simply adverting to it, and expressing our full concurrence in the views of those who have so ably advocated reform in this respect.

In conclusion, we are of opinion that there are many good features in the Bill, interwoven, however, with much which is either decidedly objectionable or of a doubtful character. In some respects it falls short, whilst in other respects it goes beyond what is required. The promoters, however, being sensible of the defects in the existing system, have honestly set themselves to frame a measure of reform. To say that they have not succeeded in producing a *perfect* Bill is only stating the fact that their work partakes of the shortcomings common to all human undertakings. What is wanted is to extract the best features in the Bill, rejecting or eliminating that which is defective, and to supplement them by other provisions where such are wanting. This, it is to be hoped, will be done in committee. We may then expect to get, as the outcome, an Act which, like the last "Patent Law Amendment Act," will form a permanent settlement for, say, the next thirty years; a patent law which shall give all necessary aid and encouragement to inventors, whilst protecting the interests of the public, by preventing or checking the grant of patents which are injurious to *bonâ-fide* inventors, a fraud upon the Crown, and prejudicial to the community at large.

THE MOTIVE POWER FOR DRIVING DYNAMO-ELECTRIC MACHINES AT THE CRYSTAL PALACE.

III.

IN our last article we referred to the rotary engines of Mr. Hodson and the "Otto" gas engine of Messrs. Crossley Brothers. We shall now proceed to notice another type of the small engines which have done such good service at the Crystal Palace.

Mr. E. S. Hindley, of Bourton, Dorset, exhibits, in a separate annexe opening to the west corridor, two horizontal engines of 10 and 6 horse-power respectively, and a vertical engine mounted on four travelling wheels, with horse shafts, having a dynamo-electric machine mounted on the same frame.

The 10-horse-power horizontal engine is one of E. S. Hindley's new design, extremely simple and accessible in all its parts, which are strongly made and well-proportioned. The cylinder is 10 in. diameter with 14 in. stroke; the crosshead slipper has a very large wearing surface. The crank and crank shaft bearings are of gun-metal, long and heavy, and are all interchangeable. The governor is one of E. S. Hindley's special new speed equilibrium pattern, and is arranged on the top of the cylinder, forming with the starting valve one casting. The perfect control which the governor has over the engine without the use of complications, such as automatic valve gear, is shown by the remarkable steadiness with which it works. The boiler is of the vertical type, with a large firebox, and 30 vertical tubes, 2½ in. in diameter, giving proper combustion and a large amount of heating surface. This engine supplies power to an alternating current Gramme machine, which feeds 20 Jablochkoff lamps on four circuits, and the very steady light given off testifies to the efficiency and uniform speed of the engine.

The 6-horse-power horizontal engine is of similar construction to the above. It is not yet in full work, only 10 Joel semi-incandescent lights, absorbing about a fourth of its power, being as yet driven from it. Other lights are being fixed, the dynamo-machines for which are intended to be driven from it.

The 4-horse-power vertical engine is of E. S. Hindley's ordinary design, adapted to electric lighting purposes. A strong angle iron frame is bolted to the cast-iron foundation, and on this a Gramme dynamo-electric machine is fixed, driven by a belt direct from the fly-wheel. The whole is mounted on four strong travelling wheels, with horse shafts, and, with the exception of one other exhibit, is the only portable set of lighting apparatus shown. It supplies power and current for 60 Swan incandescent lamps which light up the annexe. These are distributed 20 each in two coronas, and the remainder around the walls of the building, giving a very good effect. The lamps are driven up to a fair illuminating power, but not to their limit, and are capable of lighting a space several times larger than that in which they are shown.

The success of the application of these engines to lighting purposes serves to show that an ordinary engine really well designed and constructed may successfully be used. We have made various inquiries as to the actual behaviour of Hindley's engines at the Crystal Palace, and the general impression is of a satisfactory nature, especially amongst those in charge of the Joel system of lighting. Should their lasting capabilities equal their simplicity, their employment may be looked upon as effecting a considerable saving in the usual cost of an electric lighting installation.

THE BEHAVIOUR OF GAS CARBON UNDER PRESSURE.

By W. F. NOSWORTHY.

IT was stated in the evidence given at the recent telephone trial that the electrical resistance of gas carbon, unlike that of plumbago, does not vary under pressure. This statement, as I shall endeavour to show, needs considerable qualification before it can be accepted as approximately true.

Some time ago having occasion to examine into the behaviour of various kinds of carbon under different degrees of pressure operating on powdered and solid plumbago, coke, carbon as supplied for electric lighting, and retort carbon, I obtained in every instance unmistakable indications of increased conductivity, greater or less, in proportion to the force employed in compressing them. The samples of gas carbon showing a reduction in resistance of from 18 to 30, and even 40 per cent. under great pressure.

Since reading the report of the telephone case, as also an experiment quoted and illustrated in the ELECTRICAL REVIEW of February 25th, I have been induced to repeat my experiments on the substance, gas carbon.

In these experiments the measurements have been executed by means of a "divided metre bridge" (fig. 1),

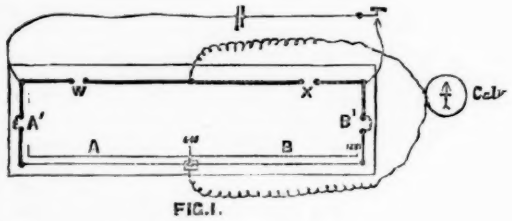


FIG. 1.

the scale of which, for special reasons, is divided into 1,280 equal parts. By this means the resistances of A′ + A, B + B′, and W being known, the resistance of X can be calculated with great accuracy to within ·001, or even less, of its resistance. In the present case A′ + B′ being closed by thick copper latches, the scale readings themselves represent the ratio of the resistances W and X with sufficient accuracy so that it will be unnecessary to introduce the actual resistance of A and B into the calculations. The two sides of the "divided wire," A, B, and a coil of No. 35 silk covered copper wire, having a resistance of one B.A. unit, form the three arms, A, B, W, and the carbon with leads of No. 35 copper wire, the fourth or X arm of the balance. A delicate astatic reflecting galvanometer, and two large Daniell cells of low resistance, complete the arrangement. The resistance of W was determined as follows:—A′ and B′ being closed by massive pieces of copper, a coil of one B. A. unit (certified as correct at 21° C.), was unplugged in a resistance-box

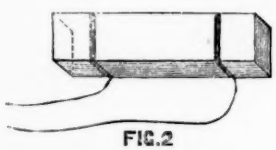


FIG. 2

inserted at X, and the length of a No. 35 copper wire, introduced into the circuit at W, was then gradually reduced until balance was established, the position of the indicator being opposite 640 on the scale. The position of X and W being reversed, balance was as nearly as possible maintained.

Two resistances, each equivalent to about 100 metres of the wire, A, B, were then inserted, one at A′, the other at B′, and W again adjusted as nearly as possible to X.

A′ and B′ were next replaced by resistances equivalent to 1,000 metres of A B when W was again adjusted. In this way W was rendered equal to X, the probable error being certainly less than ·001 of a unit. The temperature at the time of measurement being also 21° C., no correction of W was required. Calculations based on the weight and length of W gave the resistance as 1·0008 and 1·0009 respectively. The mean of the three values thus obtained gives 1·0006 nearly as the value of W in B. A. units.

The carbons consisted of six small bars, each of about 25 millimetres in length and 6 by 6 millimetres cross-section, selected and cut from as many different pieces of retort carbon. The connections were made by means of a No. 35 copper wire tightly wrapped six times round the carbon in the position indicated in fig. 2. Great care was taken to ascertain that the connection was good before commencing each experiment. The resistance of the carbon itself was found to average about 0·25 B. A. units.

No. of Experiment.	Condition of Carbon.	A	B	W ohms.	X+Y* ohms.	X* ohms.
1	Before compression	640	640	1·000	1·000	0·249
	After slight compression ..	650	630	,,	·969	·218
	After slight increase ..	660	620	,,	·939	·188
	Carbon chipped at ends by increased pressure.					
2	Before compression	630	650	1·000	1·032	·281
	After slight compression ..	640	640	,,	1·000	·249
	,, ,, increase ..	656	624	,,	·951	·200
	,, increased compression	664	616	,,	·928	·177
	Carbon chipped by increased pressure.					
3	Before pressure	660	620	1·000	·940	·189
	After slight pressure ..	670	610	,,	·910	·159
	,, increased pressure ..	690	590	,,	·855	·104
	Pressure reduced	670	610	,,	·910	·159
	,, further reduced ..	665	615	,,	·925	·174
	,, ,, ,, ..	665	615	,,	·925	·174
	,, increased	680	600	,,	·882	·131
	,, reduced	670	610	,,	·910	·159
	,, increased	684	596	,,	·871	·120
	,, ,, ...	685	595	,,	·868	·117
	,, ,, ...	690	590	,,	·855	·104
	,, ,, ...	692	588	,,	·849	·098
	,, ,, ...	692	588	,,	·849	·098
	Carbon broken by increased pressure.					
4	Before compression	660	620	1·000	·940	·246
	After ,, ...	674	606	,,	·900	·206
	Pressure increased	680	600	,,	·882	·188
	,, ,, ...	681	599	,,	·880	·186
	,, ,, ...	681	599	,,	·880	·186
	Carbon chipped at one end.					
5	Before pressure	660	620	1·000	·940	·252
	After ,, ...	670	610	,,	·910	·222
	,, increased pressure ..	680	600	,,	·882	·194
	Pressure reduced	666	614	,,	·922	·234
	,, increased	682	598	,,	·876	·188
	Carbon broke under increased pressure.					
6	Before pressure	550	730	1·000	1·327	·227
	After ,, ...	560	720	,,	1·286	·186
	,, increased	566	714	,,	1·261	·161
	,, ,, ...	568	712	,,	1·253	·153
	,, ,, ...	570	710	,,	1·245	·145
	,, ,, ...	574	706	,,	1·230	·130
	Pressure reduced	560	720	,,	1·286	·186
	,, further reduced ..	554	726	,,	1·310	·210
	,, ,, ,, ..	554	726	,,	1·310	·210
	Carbon on examination found to be sound.					

The necessary pressure was supplied by a vice, pieces of leather being interposed between each cheek and the carbon, to insulate the latter.

In the first experiment the lengths of the wires attached

* X + Y = res. of carbon + leads running to vice. X = res. of carbon only.

to the carbon were so adjusted as to exactly balance W. This however not being necessary, in all other cases, to economise both time and labour, the normal value of X has been calculated from the scale readings, when balance was established, immediately before the application of pressure.

Connecting up a bar of carbon with the bridge and establishing balance, on striking the carbon the spot of light started from zero in a direction showing that the resistance in the X branch of the balance had been momentarily reduced; the harder the blow the greater the deflection from zero.

The carbon used in the last experiment was then joined up in circuit with one large Leclanché cell and the primary of an induction coil, the resistance of which was ·5 ohms, and the telephone connected with the secondary coil. On striking the carbon every blow was distinctly heard in the telephone. Discarding the induction coil, and employing a telephone with a resistance of 4 ohms, every blow was still distinctly heard. Employing a telephone of high resistance compared with that of the rest of the circuit, I failed to detect the slightest sound. The reason is obvious.

It is scarcely necessary to mention that in these experiments the telephone was removed beyond reach of the direct sound of the blows. Enough has been said to show that the resistance of gas carbon is sensibly reduced by compression; nevertheless, the variations caused by sound-waves impinging, directly or indirectly, against it, would be so infinitesimal as to be altogether inappreciable, even by our most sensitive instruments of research, and in this sense only is the statement noticed at the commencement of this paper acceptable.

ON PHOTOMETERS.

IV.

PHOTOMETERS IN WHICH THE STRONGER LIGHT IS WEAKENED BY DISPERSION.

WE are indebted to the astronomers for the conception of many very beautiful systems designed for the photometric comparison of the heavenly bodies, but which are also applicable to the comparison of ordinary sources of light. Herschel, in comparing the light of two stars, weakened the stronger one by reducing the aperture of a telescope directed towards it, by a diaphragm placed in front. And it may be mentioned here also that a similar suggestion has been made more recently by Mr. Dawes,* who employs in the axis of his telescope a movable diaphragm, which, according to its distance from the focus, allows various proportions of the cone of rays to be cut off. We have, of course, nothing to do with astronomical photometry here, and we shall, therefore, not trouble our readers with any account of methods designed expressly for astronomical purposes, further than in so far as they may have been the forerunners of methods which are or may be found useful for the purposes which come within our scope. Humboldt's photometer, which he calls an astrometer, is based upon the same principle as Herschel's. He makes use, however, of a sextant of ordinary construction. Every one knows that the telescope of a sextant is directed towards a small square of glass, half of which is silvered and the other half left plain; and that the observer sees the image of one star (or light) direct in the plain half, and the image of another star (or light) reflected into the silvered half from another mirror.

When the alidade of the sextant is placed upon the zero point of the limb, the two mirrors being parallel, and if the instrument is directed towards a star, there are seen in a telescope which is parallel to the limb, and inclined about 15° to the small mirror, two images of the star, the one direct through the unsilvered part, and the other indirect, arriving at the telescope after two successive reflections in the large mirror and the unsilvered part of the small mirror. The latter image is naturally weaker than the former, but there is a means of rendering the two images of the same apparent intensity. The telescope, according to the construction of the sextant, is not capable of being turned on its axis, but it is furnished with a screw by which it can be made to approach to or recede from the limb, while remaining parallel to it. As a result of this motion, it is evident that visible images caused by the direct and reflected rays of the same star (or light) which fall upon the object-glass (the first passing through its upper part, and the second through its lower part) may be varied in intensity. If the telescope, for instance, be brought near the limb, the object-glass will receive more of the reflected rays, and consequently the intensity of the reflected image is augmented, while the intensity of the image given by the direct rays appears to be diminished, and a point may be arrived at where the intensities of the two images are apparently equal. If this position be ascertained for a star, it is afterwards, according to Humboldt, easy to compare two stars. For this purpose it is sufficient to direct the telescope to one of them, and afterwards to turn the alidade until the reflected image of the other star is perceived near this direct image, and the eye easily takes account of which is the more luminous; and by different similar comparisons the compared stars may be arranged according to their luminosity. Bright points are naturally more difficult to compare than illuminated surfaces, a fact which suggested to Steinheil his beautiful dispersion photometer.

Steinheil's dispersion photometer.—This photometer consists of a telescope, the object-glass of which is cut into two halves. Before each half is placed a right-angle prism of glass which acts as a mirror. The whole is so placed that the observer sees in one-half of the objective the reflected image of one star (or light), and in the other half the reflected image of the other star (or light). Then the two halves of the objective are separately slid outwards, out of focus, so that the distinct images cease to be observed, but dispersion images of the two lights take their places, and which become weaker the larger they are made—that is to say, the farther the two halves of the object-glass of the telescope are slid out. Each half is provided with a rectangular diaphragm, the opening of which can be adjusted. The observed images of the two stars (or lights) therefore appear to the eye in the form of two closely neighbouring equally illuminated rectangles, and which are consequently under the most favourable conditions for the comparison of very small differences of illumination. Had it not been for this beautiful dispersion photometer—for which Steinheil has never received sufficient credit—exact comparisons between the brightness of fixed stars and planets would not have been possible, although its immediate forerunners—the photometers of Herschel and Humboldt—had been noteworthy advances upon earlier attempts.

Passing over various subsequent suggestions between Steinheil's time and ours, to make improvements in his dispersion photometer applicable to special purposes, we may here mention a recent modification specially applicable to comparing lights of very different powers, such as electric light with standard candles, and which may be found to be useful.

*Ayrton and Perry's dispersion photometer.**—In the photometer described by Messrs. Ayrton and Perry they employ a concave lens at one end of a sort of photographic camera, on the bellows principle, through which the light under examination passes and illuminates a paper screen placed at the other end of the camera. The frame which carries the lens slides on a stand which has marked divisions, so that a pointer tells the distance from the focus of the lens to the paper screen. The standard candle is contained in a darkened box, one end of which is provided with a similar paper screen, and which is placed beside the camera for comparison. In a more recent improvement the shadows of a rod are thrown by the dispersed light and by the standard candle simultaneously upon a sheet of white blotting-paper, while a mirror is arranged to reflect the light from any required angle. We propose to give shortly a detailed description of this photometer in its improved form.

PHOTOMETERS IN WHICH THE WEAKENING OF THE LIGHT IS EFFECTED BY PERIODICAL OBSTRUCTION.

To Talbot † is due the suggestion to weaken the stronger light by means of a rotating disc with alternate black and

* "Monthly Notice of the Astronomical Society," xxv., 228 (1866).

* "Proc. Phys. Soc.," vol. iii., p. 184.

† "Phil. Mag.," Nov., 1834, p. 327.

transparent sectors, a method which has been subsequently employed with modifications by both Babinet and Secci. In THE ELECTRICAL REVIEW of Jan. 21st last, p. 36, we published a description of an improved form of this instrument by M. Napoli.

Schafhäutl's* photometer is based upon persistency of vision. He assumes that when two successive and equal impressions are made upon the retina, the time which can elapse without the eye becoming cognisant of the interruption is proportional to the square root of the intensity of the light producing the impression. Schafhäutl's apparatus consists of a steel spring fixed at its lower end by an adjustable clamp, so as to stand up vertically when at rest. On its upper end is fixed a light rectangular screen of thin sheet copper, which is blackened and provided with a slit in its centre. The screen with its slit is arranged to vibrate in the space between two tubes coincident with the axis of which is placed the light to be measured, and which is only visible to the observer when the slit coincides exactly with the axis of the tubes. The spring is set vibrating, and is then shortened until the image of the light observed through the tube no longer twinkles, but appears to be perfectly steady. According to Schafhäutl, the intensity of the light is then proportional to the square of the period of oscillation of the spring. The employment of the phenomenon of persistency of vision for photometric purposes is highly interesting, as being a new departure, and although the author of the suggestion may have underrated the complexity of the subject, there is much in it which is worth a careful working out.

PROCEEDINGS OF SOCIETIES.

THE SOCIETY OF TELEGRAPH ENGINEERS AND OF ELECTRICIANS.

AN ordinary general meeting of this Society was held on the 11th inst., Lieut.-Col. WEBBER, R.E., president, in the chair. The minutes of the last ordinary general meeting having been read and confirmed, and the list of new and proposed members given, a paper was read by Professors AYRTON and PERRY on "Measuring Instruments used in Electric Lighting and Transmission of Power." The authors commenced their paper by saying that accurate measurements in electric lighting and the transmission of power must form the basis of commercial success, and they therefore thought that a description of instruments for making measurements would prove interesting. The chief object of these instruments was to enable strong currents to be measured. In no galvanometric instrument were the degrees of deflection directly proportional to the currents that produced these deflections, and there was no easy method of calibrating such instruments. The authors had endeavoured to produce a galvanometer, on the principle of the apparatus of Marcel Deprez, which would give the desired result; but they did not succeed in making it give absolutely accurate indications. By arranging the coil in a peculiar shape an instrument was obtained which gave very fair results. The authors next described their Ammeter or current measurer, an account of which is given in the number of the Review for June 1st, 1881, page 225. The series and quantity arrangement in this instrument is very useful for measuring currents of various strengths. The resistance of the apparatus is ·005 when in parallel circuit, and ·300 when in series. Strictly speaking the resistance in one case should be 100 times as much as it is in the other, but the apparent error is due to the resistance of the leads. The Voltameter, which is used for measuring electromotive force, in construction is very similar to that of the Ammeter; a constant is taken with a known electromotive force acting through the coils joined up in parallel arc, and then the electromotive force measurement is made with the coils joined up in series. The instrument enables horse-power to be measured, since current × electromotive force × ·00134 = horse-power; it is so arranged that strong currents cannot be sent through the coils when they are joined up in series. The resistance of the coils is 400 ohms. By joining up the thick wire of the apparatus in the main circuit of an electric lamp, and connecting the fine wire coil as a shunt between the terminals of the lamp, then a joint effect is obtained which enables the horse-power consumed to be easily found. The two instruments described were constructed with powerful permanent magnets; there was, however, an objection to the use of the latter, as they lose their power. The authors had therefore designed an arrangement in which a spring was substituted for the permanent magnet. The instrument was provided with a soft iron needle, the axle of which had a toothed quadrant fixed to it, which geared into a pinion on which the indicating hand was secured. By this device a very small movement of the needle could move the index-hand through an angle of 360°, and, as the movement of this needle was in all cases very small, the angular deflection of the index-hand in degrees accurately represented the current strength passing through the coils of the apparatus. The movements of the needle were controlled by two springs. Owing to the instrument having no permanent magnet, it would answer, to a certain extent, for measuring alternating currents. Another instrument exhibited by the authors had the needle held over by a spring, so that no deflection was produced until the current exceeded a certain strength; by this means the full range of the scale could be used for obtaining indications. In order to measure the resistance of an electric light circuit an instrument with two coils at right angles could be used—the one coil giving the current in the direct circuit, and the other the electromotive force at the ends of the circuit; the difference between the two forces gave an indication from which the resistance could be determined, since

$$R = \frac{E}{C}$$

For measuring very high electromotive forces the electrometer was the preferable instrument to use, as there was no wire in it to become fused or otherwise injured by the high tension of the current; the controlling force could be a small spiral spring. This instrument could be used for measuring rapid reversals. For measuring power consumed, the authors had devised an apparatus which consisted simply of a small electro-motor; by observing, after a definite time, how many revolutions the wheel had made, the work exerted could be ascertained. The authors mentioned that since devising this apparatus they had found that Edison had previously done the same thing. For measuring power exerted the authors had invented their dynamometer coupling, by which the amount of torsion on the driving shaft of the dynamo could be ascertained. For measuring candle-power the dispersion photometer was employed. It was found that this instrument always gave higher results than those obtained by the direct method, probably in consequence of the absorption caused by the air on the latter not being taken into account. For making calculations they had devised a circular slide rule, which enabled the results to be quickly worked out.

At the conclusion of the paper, Dr. OBACH described his ring galvanometer (see ELECTRICAL REVIEW, August 1st, 1879, p. 239), and also the power dynamometer of Hefner von Alteneck. A potential dynamometer was also shown.

In the discussion which followed the reading of the paper, Messrs. C. V. BOYS and J. E. H. GORDON took part. The meeting then adjourned.

THE ROYAL SOCIETY.—The Council of the society have selected the following fifteen from the fifty-two candidates for the Fellowship who have presented themselves during the present session. The election, which rests with the Fellows of the society, will take place on Thursday, June 8th, at 4 p.m. The names are—Professor V. Ball, Dr. G. S. Brady, Dr. G. Buchanan, C. Baron Clarke, Francis Darwin, Professor W. Dittmar, Dr. W. H. Gaskell, Mr. R. T. Glazebrook, Mr. F. Ducane Godman, Mr. J. Hutchinson, Professor A. Liversidge, Professor I. Malet, Mr. W. D. Niven, Mr. R. H. Inglis Palgrave, and Mr. W. Weldon.

* "Abbildung und Beschreibung des Universal-Vibrations-Photometer." Münchner Abhandl., vii., 465.

CORRESPONDENCE.

TO CORRESPONDENTS.

No notice can be taken of anonymous communications. Whatever is intended for insertion must be authenticated by the name and address of the writer, not necessarily for publication, but as a guarantee of good faith.

Correspondence should arrive not later than Tuesday morning if it is desired to appear in the following number

THE CANDLE-POWER OF ELECTRIC LAMPS.

To the Editor of THE ELECTRICAL REVIEW.

SIR,—On several occasions I have called your attention as touching the necessity of having a practical test applied regarding the true candle-power of the arc lights. I have been out of the country for six months, but still on return observe in the ever-recurring advertisements that lights are called of "two thousand candle-power," which I need not tell you is *not* the case. Notably the Brush Company designate their street lamp as of that power, which is simply absurd, and to the public most misleading. This company has financially been a great success, and now the floodgates seem to be opened, and we are inundated with Brush prospectuses for all climes. I desire for all electric light companies success; but it is indeed strange that the company in question have been turned out of most places where they have essayed to try this "broom"; and yet in spite of such seem to go on the even tenor of their way flourishing. Before, however, they can hope to obtain a position as a truly desirable and reliable light provider they must have a lamp of less unearthly colour, one more steady, less liable to frequent extinctions; and, above all, the company should be correct in their statements as to the candle-power of their regulator. If I might express an opinion, I should say the real photometer value of the light they designate as "two thousand" is not, if much over, eight hundred.

Yours obediently,

May 13*th*, 1882. ELECTRON.

[We do not know to what our correspondent refers when he states that the Brush Company has been unsuccessful in many of its essays; perhaps he will kindly back up his assertions by facts, or we must conclude that he is mistaken. Touching the candle-power of these lamps, we may say that "Electron" shares the general opinion.—ED. ELEC. REV.]

THE CRYSTAL PALACE ELECTRICAL EXHIBITION.

To the Editor of THE ELECTRICAL REVIEW.

SIR,—Is not the Crystal Palace jury a mistake altogether? This question, which you put in an article in THE ELECTRICAL REVIEW of April 8th, p. 247, is one that would, I think, be answered by the majority of the exhibitors in the affirmative.

When at the Crystal Palace a few weeks since I heard of a case of interested bias on the part of one of the jurors, who is also an exhibitor. This juror, in conducting gentlemen around the Palace, did not take them to see the exhibits of the same class as his own, and of which his is an outcome; but hurried by the Stands as if the exhibits were things to be shunned. If other gentlemen on the jury who are peculiarly interested in the exhibits are as prejudiced against any competing system as the one of their number with whom I have been thrown in contact, I do not wonder at Messrs. Siemens and Swan declining to have their exhibits judged by the jury as now constituted. (See THE ELECTRICAL REVIEW* of the 13th inst., p. 347.) Other exhibitors will no doubt follow the example of Messrs. Siemens and Swan.

Yours faithfully,

May 15*th*, 1882. M. S. T. E.

GRISCOM MOTORS.

To the Editor of THE ELECTRICAL REVIEW.

SIR,—Would you kindly inform me of the price of a Griscom motor suitable for driving a sewing machine, and also how many cells of Leclanché's or Bennett's iron battery are necessary to generate the current which is to act upon the motor?

I would be obliged if I could get the answer in the next issue of your Journal.

I am, Sir,

Your obedient servant,

GEORGE LARSON.

Kopparberg, Sweden, *May* 12*th*, 1882.

[We cannot say how many of Bennett's elements would be required for driving a Griscom motor, but six agglomerate Leclanché cells of the new firing form would work it for a short time. The best results are obtained by employing a battery of six (three pint) bichromate cells. Price of motor £2 10s., with battery £6. This motor and its accessories may be obtained of London electrical manufacturers; see advertisement columns of this Journal.—ED. ELEC. REV.]

* We desire to call the attention of "M. S. T. E." to "Notes" of this week.

THE ELECTRIC LIGHT COMMITTEE.

CONTRARY to expectation, the Select Committee upon the Board of Trade and other Electric Lighting Bills promoted this session resumed their inquiry on Thursday week, the day on which the remains of Lord Frederick Cavendish were interred.

The chairman, Mr. E. Stanhope, explained that the propriety of adjourning over that day had been considered, but the committee had decided, in view of the public importance of the subject before them, to proceed as usual.

It may be as well here to explain that, for the simplification of the inquiry, the various interests affected and taking part in the proceedings have been classified into the following groups:—1. Electric lighting companies; 2. Municipal corporations and local boards who now supply gas within their own boroughs and districts; 3. Municipal corporations and local boards who now supply gas both within their own boroughs and districts and also within other districts; 4. Municipal corporations and local boards whose districts are supplied with gas by gas companies; 5. Municipal corporations and local boards whose districts are supplied with gas by other municipal corporations; 6. Road authorities; 7. Water, gas, and other companies whose works may be interfered with; 8. Private persons, traders, and others who are to be supplied with electric light or power.

Sir Joseph Heron, the town clerk of Manchester, a gentleman of long and wide experience in Parliamentary committee-rooms, was the first witness examined on behalf of these general interests, Mr. Farrar, of course, having represented the Government. Sir Joseph Heron not only represented the corporation of his own powerful city, but something like 150 other boroughs and local boards, with a joint capital involved of forty or fifty millions. The Manchester corporation supplied gas to 400,000 people in their own district, and 250,000 people in outlying townships, and had for some years spent about £50,000 a year on municipal improvements out of the profits of their gas undertaking. The corporation had no objection to the electric light, and, on the contrary, would do all they could to assist its development; but they strongly objected to any authority but themselves having the right to come in and break up streets, as would be necessary in the laying of electric wires. The actual interests of the borough were secured in this respect by the Bill, so far as licences were concerned to applications, for which they could refuse assent; but not so in regard to the outside districts which the corporation were supplying with gas, because only the assent of the local authorities would be required as the Bill stood. Mr. Farrar had suggested a proviso enabling all the parties to an application to be heard upon it, but the corporation felt that that would not be sufficient; and their contention was that licences should be placed in the same position as provisional orders, and in that way the parties would be able to appeal to Parliament against a decision by the Board of Trade. The corporation had the strongest objection to being left entirely in the hands of the Board of Trade. He further urged the desirability of keeping lighting supplies in the same hands, and preventing the reckless starting of companies which might

be only bogus companies. If, however, local authorities were to have the power to admit electric lighting into their districts, then the gas-supplying corporations should be elieved of their existing obligation to supply to all who require gas.

In cross-examination by Mr. Moulton, on behalf of the electric lighting companies, Sir Joseph Heron admitted that while he held that the electric lighting ought to be in the hands of gas-supplying corporations or companies, that monopoly ought not to be granted except upon definite conditions; and means must be adopted to prevent any obstacles being thrown in the way of electric lighting. In support of his view as to the preferential rights of a gas-supplying corporation, he cited as an analogy, the case of the acquisition of the telegraphs by the Government, for the Government acquired that monopoly in the public interest; and the Corporation of Manchester, as they spent the public money, were seeking to do the same.

In reply to Mr. Fitzgerald, who represented several Scotch burghs, Sir Joseph Heron stated that, although the introduction of the electric light might reduce their profits from gas, the corporation would not obstruct its adoption; and in replies to other counsel, he said that if the licences proposed by the Bill were to be only and specifically for the purpose of making experiments then he would not impose on the electric company the compulsory obligation to supply. But at present it seemed to him that the electric lighting companies were to have a roving commission to go where they chose, and to break up streets as they pleased.

Sir Joseph Heron was then catechised by the several members of the committee, and in the course of his answers he admitted that a limitation of the proposed licences to five years for experiments without power of renewal would be more satisfactory; and he explained that his anxiety to have an appeal to the House of Commons, as in the case of a provisional order, was due to his impression, founded upon Mr. Farrar's evidence, that corporations could not expect much consideration from the Board of Trade. The general result of his evidence was that while his corporation did not desire to prevent experiments in electric lighting the corporation should have a priority of claim to the supply. Sir Joseph Heron finally pointed out that as the Bill now stood it would be possible for local districts to admit electric light companies, who might select the most remunerative part of the district for their operations, and leave the remainder unsupplied. The gas-supplying corporation or company in such a case would then have to light the least profitable part of the district under their legal obligations, and thus they might sustain a loss. Evidence of a similar character was subsequently given by the town clerks of Nottingham and Leeds, and the inquiry was adjourned.

On Friday this branch of the investigation was again pursued, Mr. Mosscrop, chairman of the gas committee of the Bolton Corporation, being the first witness. He explained that not only had his corporation spent half a million in acquiring and extending the old gasworks, but were now proposing further extension and expenditure. By the conditions of their purchase the corporation were bound to supply outlying districts, and of course if the electric light were allowed to be introduced by strangers the corporation must suffer loss. The corporation, therefore, he maintained were entitled to the first right, and they were, in fact, seeking powers to introduce the electric light themselves.

Mr. E. L. Gaine, town clerk of Blackburn, urged the Committee to restrict licences to experiments, and to omit the provision for renewing them. He also suggested that the licences should run only for three years, deeming that a sufficient period for testing the possible commercial success of the light; and he pressed the importance of the mere possession of a licence not being allowed to be regarded as an undertaking which might be carried on to the injury of the gas-suppliers. The corporation were the gas-suppliers for Blackburn and the surrounding districts, and he supported previous municipal witnesses as to the preferential rights of the corporations to supply electric light if they chose. This view he held on the ground that the municipal authority ought to control the streets in regard to breaking them up, because of the large amount of money spent in such cases as this, and because, as had happened in regard to gas, eventually the corporations would be obliged to buy up the electric light undertakings. After this witness's examination, Mr. Littler, with the approval of the committee, decided to call no more evidence upon this part of the inquiry, because the dozen or more corporations who would be willing to furnish witnesses took almost identically the same view as those already represented. Mr. Littler addressed the committee on behalf of the gas-supplying corporations, and the committee adjourned till Monday.

On Monday the case of the gas companies was opened by Mr. Pope, Q.C., who at once disclaimed on their behalf a desire for anything like a monopoly, or any exemption from the vicissitudes of ordinary competition and the progress of scientific investigation and invention. But as they had been placed under compulsory obligations to supply gas as a condition of their quasi monopoly, they ought to be relieved from that liability if a competing system of lighting was to be authorised. He objected to legislative stimulus to any undertaking, thinking that local authorities and speculative companies might very well be left to themselves in such matters. The practicability of electric lighting could only be tested on a large scale outside the laboratory, but at present there was no sufficient information as to the result of the experiments which would enable the Legislature to lay down the conditions of supply, such as were imposed on gas companies. Until that was obtained, legislation was premature, except so far as it was necessary to secure the conditions by which the experiments might be carried on. At all events, the gas companies must be relieved of their obligations if a competing system was introduced.

Mr. Michael, Q.C., argued the case of the Liverpool Gas Company, who rested their opposition mainly on the contention that it was an established and sound principle that public funds should not be used to compete with private undertakings. He urged that local authorities should be struck out of the Bill, and private gas enterprise be left to take its chance against a new system of lighting.

Mr. Rayner, town clerk of Liverpool, was examined in support of the case of the Liverpool Corporation, which does not supply gas, but three years ago obtained powers to make a series of electric lighting experiments; and Mr. McEvoy, of Dublin, also gave some evidence from a somewhat similar point of view—viz., in favour of the preferential rights of corporations. On Tuesday Mr. Dunscombe, the municipal engineer of Liverpool, explained that the electric light experiments in that city had failed so far because the wires when carried overhead had been tampered with by people, and the corporation had been unable to allow the wires to be laid under the carriage-way or footpaths because of certain peculiar conditions, such as asphalte and private cellars extending beyond the kerb. He suggested that the ordinary granite kerb might be replaced by a hollow iron kerb, in which the wires might be laid.

Mr. Wright addressed the committee on behalf of the Liverpool Corporation, and shortly after the case of the electric lighting companies was opened.

Sir Frederick Bramwell was the first witness called, and examined by Mr. Moulton. He said he was largely interested in electric lighting, and had given a good deal of attention to the subject. Since 1879 electric lighting had made great progress, the most important being the introduction of the incandescent light, which got rid of the difficulty that the Committee on Electric Lighting felt—namely, the subdivision of light, and which made it now applicable for domestic purposes. A whole town could be supplied with electric light. He had given attention to the Bill before the committee. There seemed to be a great deal of power vested in the Board of Trade by the Bill; but he presumed that it was properly left to them. The electric light would not seriously interfere with the streets; obviously, bendable tubes were much more manageable than cast-iron pipes. He would have a provision so as to have lamps used that would not interfere with other lamps. He thought that under proper circumstances the electric light might be supplied at a cost comparable with gas. He thought the electric light should be supplied in what he would call a wholesale way, by the supply of a sufficiently large district, to enable the apparatus to be put up in order to secure economy in working and in measurement. He thought the conditions ought to be such as would stimulate the proprietors to carry it through successfully. He should like to have a population of some fifty thousand at least, both for public and private lighting,

to develop the thing properly. Engines of enormous power would be required, and there would be great economy by having the thing tried on a large scale. As to certain restrictions, he did not think that any persons with capital would embark their money in carrying out electric lighting when they would have to surrender their plant at the end of seven years on the terms proposed in the Bill. If he understood the matter, everything was to be parted with, and the undertakers were only to receive the value of the land, buildings, works, and materials; the copper and steam-engines were to be sold, and the parties were to get nothing for the goodwill of the business. He did not think there was any precedent for such legislation. He believed there was a provision with respect to tramways by which local authorities could buy them up at the end of twenty-one years. But there was this distinction between tramways and the electric light—that in the former the business was already in existence and people went as naturally into tramcars as into omnibuses; but in the case of the electric light they had to be educated to use it, and consequently it would take a longer time before the electric light would get into a profitable working condition. If the Electric Company were only to have a short time for making a profit they would no doubt get the maximum price consistent with the maximum return from the business, and this would restrict the area which would benefit from the light. There was another provision that any local authority might give notice to purchase a portion of the undertaking. That was a proposition which had been put forward with regard to gas, but it had never been sanctioned. He would lengthen the time for the purchase as to electric light to at least twenty-one years. The witness was cross-examined by Mr. Michael, and said he was of opinion that the electric light had got out of its experimental stage. He belonged to the Edison Company. He was in favour of supplying the Edison light all over the country unless there was another light as good. He did not suppose that one company was to do the whole work of the United Kingdom. He did not think that the local authorities would be in a hurry to buy up the electric light; they would wait until some one else had burned their fingers, and they would take their opportunity when the thing was profitable. As to laying wires for six companies in Manchester, he thought that the Board of Trade would limit the number. To ascertain the value of the electric light at the end of twenty-one years, he would suggest that the company should be paid for the profits made at that time, and not to receive prospective profits or back dividends, as in the case of gas and water companies. The proposition of the Government, that nothing should be paid for except the undertaking itself, was so monstrous that he could hardly believe it. The witness was cross-examined by Mr. Littler. He said they would have to provide insulators and trenches to carry out their object. He did not believe there would be any more danger than with gas. He thought the Board of Trade would be able to adjust matters as to several companies in a town in such a manner as to protect the streets. He thought that gas would be largely required for the purpose of power and of heating, and that in the immediate future there would be a large market for it. After some further evidence the committee again adjourned.

OBITUARY.

THE LATE CHARLES HOCKIN, C.E.

MR. C. HOCKIN was educated at Aldenham School, and from there he entered St. John's College, Cambridge, in October, 1859, and graduated as third wrangler in 1863, and soon after became a fellow of his college.

In December, 1863, he became a pupil to Messrs. Forde and Fleeming Jenkin, and immediately commenced learning the business of submarine telegraphy. From May, 1864, to December, 1865, he spent most of his time at Rouen, as assistant on the staff of Messrs. Forde and Fleeming Jenkin, the engineers to the Rouen Waterworks Company. After this, submarine telegraphy took a brisk turn, and he was actively engaged in superintending the manufacture and testing of a cable made in 1866 for Reuter's Telegram Company—a 4-conductor cable laid between Lowestoft and the island of Norderney, on the coast of Hanover. This cable consisted of 20 knots of cable weighing about 19 tons per knot, and 200 knots weighing 10 tons per knot—one of the most successful cables ever laid. It is now 16 years old, and has only required repairs about three times, or an average of one in every five years.

After this Mr. Hockin was actively engaged in making experiments and working out practical results for the Committee of the British Association, for the purpose of determining the standards for electrical resistance; these experiments extended over a period of about one year.

From August 1868, to the end of the year 1871, Mr. Hockin was constantly employed as engineer and electrician on the staff of Messrs. Clark and Forde, and during that time had constant and hard work in connection with the superintendence of the manufacture, laying, and testing of many thousand miles of cable; amongst the number, the French Atlantic Cable, laid in 1869, between Brest (France) and the island of St. Pierre and Duxbury, in the United States. The Brest-St. Pierre section contains a length of cable of 2,584 knots, containing the heaviest core—viz., 400 lbs. copper and 400 lbs. gutta-percha per knot—ever laid. From careful experiments made on this long section, Mr. Hockin determined in a practical manner the theoretic speeds for all future cables, from which most useful tables of speeds were calculated and published.

At the beginning of the year 1872 Mr. Hockin joined in partnership Mr. Latimer Clark and Mr. Forde, who also took into partnership at the same time Mr. Herbert Arnaud Taylor, forming the now well-known firm of telegraph engineers of Clark, Forde and Co., who have up to this date been professionally engaged in carrying out nearly all the long submarine cables connecting this country with Lisbon, Gibraltar, and numerous ports in the Mediterranean, Egypt, India, China, Australia, New Zealand, United States, Brazil, and on the West Coast of South America and many other places.

Mr. Hockin's high attainments as a mathematician and electrician made him a most valuable partner in his firm, and up to almost the day of his death (which happened on April 26th last) he never ceased to study and improve his knowledge in this direction. He was considered by all scientific men as second to none as an authority, not only in electrical but also in general science, and especially in nautical astronomy. His amiability of disposition, straightforwardness, and his professional integrity, were remarkable, and he never seemed to weary of imparting knowledge to all those who consulted him on professional business.

In his family circle he was greatly beloved and much looked up to, and he was equally valued by his three partners, and all who came in contact with him in matters of business, or otherwise. His death, after but a short illness, caused, as was believed, by a return of fever contracted at Zanzibar on his last foreign trip, has caused a sad blank in his family circle, and as a partner in the firm of engineers to which he belonged.

NOTES.

ERRATA.—In our issue of last week, page 337 (Gülcher Electric Light), for "2,300 candles per hour," read 2,300 candle-power; and on page 352 (Telephone Case), for "perfect contact to affinity," read perfect contact to infinity.

GREAT ELECTRIC LIGHT COMBINATION.—We extract the following from the *Engineering and Mining Journal* of America:—"Some time since, we had occasion to announce the formation of a combination under the name of the Gramme Electrical Company of the Brush, Fuller, United States, Western, Jablochkoff, and American electric lighting companies. The only powerful concern which held aloof was the Edison Company, which now has also entered the ring. Professedly the arrangements thus entered into are made for the purpose of agreeing upon prices, of aiding in a speedy and cheap settlement of litigation, and of furthering 'harmony' among the companies interested. What such 'harmony' means, the public has pretty fully learned to

understand in connection with the management of gas, telegraph, and other companies. The contracting parties, who have been seized by a sudden appreciation of the beauties of harmonious action, have come to the conclusion that there is room for all, if the affair is properly managed. Those who are in need of electric lighting can be made to pay much rounder sums if some stern and unyielding 'Committee on Prices' dictates what the consumer must pay. However, this new ring has a paternal regard for the interests of the public, and proposes to act as its guardian angel to protect it from unprincipled schemers. It is true that, within the last four years, a large number of wild-cat electric light companies have sprung up for the purpose either of swindling shareholders or of frightening large companies into buying them out. The history of some of these enterprises, as revealed in the courts, is as remarkable as that of some mining companies, and the Gramme Electrical Company will undoubtedly do much good by cleaning them out. The only danger, however, is that in its eagerness to work out the bad, it may be led to an abuse of its power in order to kill all competition indiscriminately. It is true that it now disclaims any intention of putting a stop to legitimate enterprises; but it is only too probable that its judgment will be warped by interest. There are now in existence a number of minor concerns which have been doing good and faithful work. Their progress will be materially hampered by the existence of such a combination, which will only too quickly gain the complete control of the business. Inventors will find it a difficult matter to interest capital to engage in any attempt to carry their improvements to a successful issue. The formation of the Gramme Electrical Company may be a good thing for the stockholders of the companies belonging to the combination; but it is certainly not a union which the public at large will view with much favour."

ELECTRICAL ACCUMULATORS.—According to the *Daily Press* of last week the directors of the Faure Electric Accumulator Company, Limited, state that, acting upon the opinion of their responsible electricians, they have directed the solicitors of the company to commence legal proceedings against the Electrical Power Storage Company, Limited, for infringing the patent of the Faure Company.

THE ELECTRIC LIGHT IN SPAIN.—The Sociedad Espanola de Electricidad has entered into a contract to light the War Office at Madrid. Swan's lamps will be employed, and the dynamo will be driven by a gas engine. The same company intends supplying the electric light to the principal cafés of Barcelona, and exhibiting in actual working order different lamps and material connected with electrical lighting. From later information we understand that the installation of the electric light in the War Office at Madrid will consist of 15 large arc lamps on the Gramme system, each of 1,800 candles, and 43 incandescent lamps of Swan and Maxim, each equal to 22 candles. The arc lamps are to be placed in the grounds and principal entrances of the building on columns of 23 feet in height, and the incandescent lamps will be distributed throughout the different apartments. The electricity will be supplied from five of Gramme's dynamo-electric machines, two Maxim ditto, and one exciter, all driven by a portable engine of 40 horse-power. This arrangement will only be temporarily adopted, the company intending to replace the portable engine by a fixed one, and to make the fittings more permanent.

THE CRYSTAL PALACE EXHIBITION.—We noted last week that it was said Messrs. Siemens and Swan had refused to have their exhibits judged by the jurors; we are now assured that our information in regard to Mr. Swan was incorrect.

THE FAURE ACCUMULATORS.—We notice that the electric lights on board the *Labrador* (the ship which reported from New York her meeting with the disabled Cunard liner *Catalonia*) are fed by Faure accumulators, which are said to be an entire success.

ELECTRIC LIGHT AND TELEPHONE CONDUCTORS.—We are glad to hear that the quality of our electrical manufactures is so much appreciated on the Continent that the makers of electric light leads are now doing a brisk business in France, notwithstanding the heavy duties on such English goods going there.

THE SWAN ELECTRIC LIGHT.—We hear that a large company is shortly to be brought forward for working the Swan system.

RECENT PROGRESS IN THE ELECTRIC LIGHTING OF BUILDINGS.—At the Royal Institute of British Architects, on Monday evening last, a paper was read by John Slater, B.A., Fellow, on "Recent Progress in the Electric Lighting of Buildings":—

After referring to the revolution which the last three years had effected in the opinions of scientific men as to the sphere of usefulness of the electric light, the author observed that this revolution was mainly due to the invention of incandescent lighting, which might be defined to be the unlimited power of concentrating large quantities of heat into small foci without consuming the heated body, which thus became a stable and unchanging point of light, in contradistinction to the arc lights, in which the glowing material was continually disintegrating and burning away. The chief difficulties in the way of making incandescent lamps lay in the fact that it was necessary to inclose in an exhausted glass globe an extremely thin filament of carbon, which must be in electrical contact with wires outside the globe, and which must be able to stand an enormously high temperature. Messrs. Swan, Lane-Fox, Edison, and Maxim had overcome these difficulties in different ways. Incandescent lamps could be used with almost all kinds of dynamo machines, but they could also be worked with an invention which, as a practical means of supplying electricity, must be regarded as the outcome of the past year, but which would be epoch-making in the history of electric lighting, viz., the storage batteries, or accumulators of electrical energy. The economic value of incandescent lighting was one of the most important points to be considered, and although at present the data upon which to found an opinion were but scanty, the cases in which the details of cost had been most accurately worked out tended to show that the economic value of the new means of illumination had been, if anything, underrated. The readiness with which the incandescent lights lent themselves to any scheme of decoration was one of their chief attractions. There was no necessity for following on the lines of gas-fittings, as the conditions were so completely altered, but points of light could be placed wherever they were required, and there was no fear of blackening ceilings and decorations, or of setting fire to the most easily-ignited materials. The progress of this system of lighting had been so rapid that architects had as yet had no time to turn their attention to its decorative capabilities, but when they did so, they would find it fulfil every requirement for perfect lighting. Mr. Slater then alluded to the arc light systems, in which less progress had been made during the past year. If these large lights could be concealed, and their rays reflected downwards from a large screen or a white ceiling, a very pleasant and diffused light would be obtained, and the slight irregularities, due for the most part to the carbons, would be much less perceptible. The great difficulty with which these arc lamps had to contend was in the nature of the carbons, in the manufacture of which but little improvement had taken place. For electricity to compete with gas as a general means of illumination, it must offer as many facilities as its rival; and the Edison installation in Holborn, and that of the Swan lamps at the Savoy Theatre, showed practically that this condition was complied with. Perfect insulation throughout was the great desideratum, and if this point were always carefully kept in view, the dangers of electric lighting would be reduced to a minimum. Considerable attention had been given to this matter in America, and the Board of Fire Underwriters of New York had framed a code of regulations bearing on the subject. The Crystal Palace Exhibition was an exceptional case, as the installations were temporary, and the risks such as could not possibly occur in a well-devised permanent arrangement. Mr. Slater then referred to the importance of the subject to architects, and concluded his paper thus:—The progress of electrical science is the most striking feature of the latter part of this nineteenth century, and the day is not far distant when we shall find a certain acquaintance with the subject a necessity for us architects in our every-day work, unless we wish to be entirely in the hands of the men whom we employ. I would respectfully suggest to the council the desirability of requiring a certain amount of knowledge of physical science from the candidates in the obligatory examination that has recently been set on foot, and the results of which are already so promising.

THE EDISON ELECTRIC LIGHT.—The *City Press* says that by special invitation a number of gentlemen connected with the St. Marylebone Vestry visited the works of the Edison Electric Light Company, on the Holborn Viaduct, last week.

NEW ELECTRIC LIGHT COMPANY.—We observe in the *New York Review of the Telegraph and Telephone* that the "Swan Incandescent Electric Light Company has been organised for the Pacific Coast, with a capital of 500,000 dols."

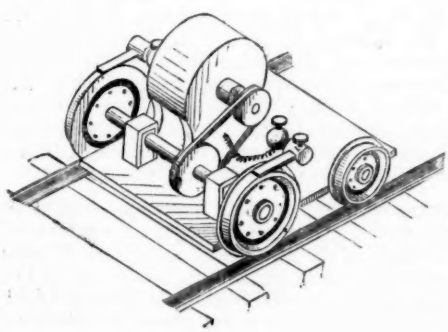
ELECTRIC LIGHT SHARES AND THE PUBLIC.—It appears that some of the recent electric light companies have been very successfully brought forward, judging by the way in which their shares have been disposed of. We hear that the applications for shares in the Pilsen, Joel, and General Electric Light Company many times exceeded the number which could possibly be allotted.

THE BELL TELEPHONE.—We read in the *Operator* that the Bell Company laughs at the claims of M'Donough, Drawbaugh, and other inventors of the telephone, but the great legal struggle has yet to come.

PRACTICAL INFORMATION FOR TELEPHONISTS.—We extract the following paragraph from the American *Operator*, thinking that many of our readers interested in telephonic matters may derive benefit by studying the experience of one who has devoted much of his time to this branch of electrical work:—"We have just issued a work upon the subject of the telephone, which we think will prove an indispensable hand-book to every telephone manager, operator, and inspector. It is called 'Practical Information for Telephonists,' and is written by Mr. T. D. Lockwood, who has for some time sustained a high reputation as a lucid writer upon electrical subjects. This latest work of Mr. Lockwood takes the reader through every phase of telephony—its history, its growth, its prospects, and, in the most thorough manner, its practical working; how to build a short telephone line; the earth and its relation to telephone systems; the magneto telephone, what it is, how made, and how it should be handled; electric bell construction, and other deeply interesting subjects are all treated exhaustively, each subject receiving a separate chapter. The article on 'The Blake Transmitter' is particularly interesting and instructive, while for inspectors who expect ever to reach the top of the profession there is much to learn in the several chapters on 'The Telephone Inspector,' 'The Inspector on Detective Duty,' and 'The Daily Routine of the Inspector.' The article on 'Electric Light Wires *versus* Telephone Wires' is highly instructive, while the oldest electrician can find something new in the chapters on Line Troubles, Switchboards, Batteries, and the various systems of individual calls.

"Altogether the book is a most interesting and useful one, and we feel no hesitation in recommending it. Cloth, price 1 dol. Mailed postage prepaid to any address in the United States, Canada, or any country in the Universal Postal Union on receipt of that amount."

WHEEL FOR ELECTRO-MAGNETIC LOCOMOTIVES.—Patent No. 257,298, filed in the United States of America Patent Office, January 5th, 1881, by E. N. Dickerson.



Claim.—The combination of an electro-magnetic engine or locomotive running upon rails, with paper wheels supporting such locomotive upon the rails, and provided with a metallic conducting-tire and springs for conducting the electricity from the track to the engine, while at the same time the current is insulated from the main frame of the locomotive, substantially as described.

THE SOCIETY OF TELEGRAPH ENGINEERS AND OF ELECTRICIANS.—The next meeting of the Society of Telegraph Engineers and of Electricians will be held at 25, Great George Street, S.W., on Thursday, the 25th May, when the following paper will be read by Lieut. A. H. Bagnold, R.E.:—"The Organisation and Operation of the Field Telegraph Corps in the Transvaal, 1881; also some General Remarks on Field Telegraphs."

PATENTS FOR DYNAMO-ELECTRIC MACHINES.—We notice that in the United States of America Patent Office, letters patent have been granted during the week ending April 4th to Friedrich von Hefner Alteneck, of Berlin, for a dynamo-electric machine. The patent was filed January 14th, 1882, and was previously patented in England, June 5th, 1873. It will be interesting to know to what extent Mr. Edison's patent is affected by this, as the method adopted by him of winding his bobbin is, theoretically speaking, identical with that of the now well-known form of Siemens machine. Practically Mr. Edison's bobbin is an improvement on that of Von Hefner Alteneck, but perhaps it may turn out that this is not sufficient to make it independent of the latter's patent.

CARBONS FOR ELECTRIC LAMPS.—Those concerned in the manufacture of carbon rods may be interested to know that in our contemporary, *La Lumière Electrique*, of the 29th April, an interesting article by M. Jacquelain appeared, "On the Preparation of Pure Carbons for the Purpose of Electric Lighting." A table is given, showing the results of various kinds of carbons, in photometric value, time of lasting, &c.

COPPER AND CONDUCTING WIRES.—Attention having been drawn to the increased demand for copper for electric light conductors and other purposes, and to the rise in its price, it appears that electricians will necessarily be obliged to turn their attention to the use of some other material or combination of materials to supply their wants.

THE AMERICAN CABLE COMPANIES.—It is announced that a joint purse agreement has been executed between the Direct United States Cable Company, Limited, the Anglo-American Telegraph Company, Limited, La Compagnie Française du Télégraphe de Paris à New York, and the American Telegraph and Cable Company.

When the old French Company was amalgamated with the Anglo Company it was foreseen that another company would come into existence. Then appeared the Direct Company. We often called attention to the fact, when the combat between it and the Anglo Company was at its height, that in the event of a joint purse arrangement, another rival would spring into existence. Our words were verified, and the new French Company has come and been drawn within the embrace of the older companies. Yet another company has been brought into existence, this time with two cables, and once again the joint purse agreement has provided for the future division of the traffic receipts. The rates are again to be (from Monday next) 2s. per word to New York and Canada. Well, and what next? Why, a short period for the said companies of blissful repose, and then probably the outbreak of a fierce encounter with yet another rival.

Our warnings on previous occasions were lightly treated, but they have since been proved correct, and so will they again in the future; for, not any number of amalgamations will restrain promoters and financiers from coming to the front, seeing that the greater the amount of capital involved in the amalgamated undertakings, the more obvious must be the chances of success of a new competitor unburdened by watered capital. Ere long, some interesting move in the cable world will be made, and probably those who have been blindly led by their directors in the matter of amalgamation, will have cause to repent that their perception has been so long obscured.

The arrangement made is as follows:—The Anglo Company will take 55·125 per cent.; the Direct Company 18·375 per cent.; the French Company 14·000 per cent.; and the

American Company 12·500 per cent. This proportion to obtain until the second cable of the American Company is ready for work, and then the division of the joint traffic receipts will be altered, the Anglo Company taking 48·825 per cent.; the Direct Company 16·275 per cent.; the French Company 12·400 per cent.; the American Company 22·500 per cent.

Taking the Anglo Company's capital at £7,000,000; that of the Direct Company's at £1,400,000 (with debentures); that of the French Company at £1,680,000; and *allowing* that the capital of the American Company is £1,800,000 (*i.e.*, 50 per cent. added to the manufacturers' price for the two cables), it will be an easy matter to ascertain which of the companies gets the best of the arrangement.

It would appear that the receipts, if divided in proportion to the respective capitals, would be—Anglo Company 58·923 per cent.; Direct Company 11·785 per cent.; French Company 14·141 per cent.; and American Company (with above supposed capital of £1,800,000) 15·151 per cent. To put this more simply, the Anglo Company gets 10·098 per cent. less than its capital would indicate as its share, and the French Company 1·741 per cent. less; whilst the Direct Company obtains 4·490 per cent. more and the new American Company 7·349 more than their respective capitals would seem to point out as their portions of the joint purse. We may refer to this subject again in our next issue.

CONTRACTS FOR TELEGRAPH MATERIALS.—Forms of tender may be had for supplying telegraph wire, telegraph fir poles, and telegraph materials, to the Great Eastern Railway Company, at their Secretary's office, Liverpool Street Terminus, E.C. The patterns may be seen at the Stores, Stratford, between 10 a.m. and 4 p.m. up to the 25th May, 1882. Parties applying should state the particular contract or contracts for which they propose to tender. Tenders endorsed "Tender for Stores," to be forwarded to the above office on or before 10 a.m. May 27th, 1882.

NEW COMPANIES REGISTERED.

AUSTRALASIAN ELECTRIC LIGHT, POWER, AND STORAGE COMPANY, LIMITED.—Capital £255,000 in £5 shares. Office, 4, Copthall Buildings, E.C. Objects: To acquire licences for the use of the Brush system and electric lighting in Australasia, and to carry out an agreement of the 11th inst. with the Brush Electric Light and Power Company of Australasia, Limited. Signatories (with one share each): *J. J. Cater, 39, Lombard Street; Arnold Trinder, 14, St. Helen's Place; Frederick Ince, St. Benet's Chambers, Fenchurch Street; William Russell Jackson, 12, Albion Terrace, Highbury; G. Shute, Jun., 14, Crooms Hill, Greenwich; C. L. Wade, 18, Old Broad Street; and Miall Fraser, 4, Copthall Buildings. Directing qualification 100 shares. Lieut.-Gen. Hamilton, Latimer Clark, Philip Falk, and Randolph C. Want, are members of the first board of directors. Remuneration £1,500 per annum. Registered 11th inst. by Ingledew and Ince, St. Benet's Chambers, Fenchurch Street.

DEVON AND CORNWALL ELECTRIC LIGHT AND POWER COMPANY, LIMITED.—Capital £100,000 in £5 shares. Objects: To obtain sale licences from the Great Western Electric Light and Power Company, Limited, for the use of the electric inventions of C. F. Brush and Lane-Fox in the counties of Devon and Cornwall. The purchase consideration is £7,500 in cash, and £7,500 in fully paid shares. Signatories: *W. N. M. St. Aubyn, M.P., 50 shares; *Thomas Pole, Bristol, 50 shares; *W. H. Owen, Exeter, 50 shares; Robert Sully, Exeter, 10 shares; John Parsons, Bristol, 10 shares; F. B. Lidstone, Exeter, 20 shares; H. J. Dixon, Exeter, 2 shares. Directing qualification 50 shares, or £250 stock. E. J. Clarke and J. E. Scott, J.P., are directors. Remuneration £1,000 per annum. Registered 11th inst. by Clarke and Co., 14, Lincoln's Inn Fields.

GENERAL ELECTRIC LIGHTING COMPANY, LIMITED.—Capital £50,000 in £1 shares. Objects: The carrying on of the usual business of an electric lighting company. Signatories (who, with one exception, subscribe for one share each): J. Andrew, 15, Marriott Road, Tollington Park; W. Baxter, West End Lane, Kilburn; J. F. Copeland, 59, Oakfield Road, Penge; A. Grant, Founder's Court, E.C.; (2,000 shares) T. Sissons, 13, Tyrrell Road, East Dulwich; E. M. Pigram, 30, Upper Tollington Road, N.; C. Harvey, 102, Gloucester Road, Regent's Park. The signatories are to nominate the first directors. Registered 12th inst. by C. Harvey, 99, Gresham Street.

SOUTH AFRICAN "BRUSH" ELECTRIC LIGHT AND POWER COMPANY, LIMITED.—Capital £100,000 in £5 shares. Office, 5, Copthall Buildings, E.C. Objects: To purchase from Messrs. D. P. Blaine and A. J. Macdonald the right to use the Brush system in the Cape of Good Hope and elsewhere in South Africa. Signatories (with one share each): A. J. Macdonald, 2, Suffolk Lane, E.C.; T. J. Plewman, 5, Lexham Gardens; G. B. Hamilton, 2, Cushion Court, E.C.; B. Lloyd, West Croydon; G. P. Balfour, 2, Observatory Avenue, N.W.; M. Anderyon, Highfield, Sydenham Hill; and *Lieutenant-Colonel G. Cox, 55, St. Charles Square, W. Directing qualification £250 (nominal) in shares. Colonel Brackenbury, R.A., T. Dickson, Peter Rhodes (of Kimberley), J. W. Anderson, C. E. Atkinson (of Port Elizabeth), are members of the first board. Remuneration £1,000 per annum. Registered 13th inst. by Johnson, Upton, and Co., 2, Austin Friars.

CITY AND SUBURBAN ELECTRIC COMPANY, LIMITED.—Capital £25,000 in £10 shares. Objects: To enter into an agreement with the Anglo-American Brush Electric Light Corporation for the use of their patented inventions. Signatories (with one share each): Robert Gordon, New Malden; J. Kayler, 29, Coventry Street, Cambridge Road, E.; H. Geaver, 133, Gray's Inn Road; R. S. Ward, 24, Grafton Street, Mile End; A. Mason, 16, Bernard Street, Russell Square; H. J. Bass, 17, Henrietta Street, Covent Garden; G. S. Fleet, Gurney Lodge, Stratford. Registered 13th inst. by Walter Webb and Co., 23, Queen Victoria Street.

PILSEN, JOEL, AND GENERAL ELECTRIC LIGHT COMPANY, LIMITED.—Capital £200,000 in £5 shares. Objects: To carry out an agreement between the Union Electric Light and Power Company, Limited, and E. T. Gregory, the latter representing this company. Signatories (with one share each): Dillwyn Parrish, 2, Copthall Buildings; W. Hodding, 14, Angel Court, E.C.; C. Noble, jun., Aberdeen; Andrew Hutton and A. Parrish, 2, Copthall Buildings; James Fyfe, 52, Queen Victoria Street; and J. Goddard, jun., 81, Gracechurch Street. Directing qualification £250 (nominal) in shares or stock. The signatories nominate the first directors; remuneration £1,500 per annum. Registered 15th inst. by Paines, Layton, and Pollock, 47, Gresham Street.

METROPOLITAN (BRUSH) ELECTRIC LIGHT AND POWER COMPANY, LIMITED.—Capital £1,000,000 in £5 shares. Objects: To work the Brush system of electric lighting within the metropolitan postal district; and to adopt an agreement, of 15th inst., between the City and Suburban Electric Company, Limited, and Arthur Davis (for this company). Signatories (with one share each): *Walter Low, 23, 24, 25, Billiter Street; *Gen. Sir M. K. Kennedy, R.E., 26, Leinster Square; *A. R. Grenfell, Windsor; A. Thomson, 42, Tregunter Road, South Kensington; *A. Wood, 14, Great Winchester Street, E.C.; *J. Whitehead, Catford Bridge; *Thomas Dickson, South Norwood. Directing qualification £250 (nominal) in shares or stock; remuneration £2,000 per annum. Registered 16th inst. by Walter Webb and Co., 23, Queen Victoria Street.

ELECTRICAL ASSOCIATION, LIMITED.—Capital £50,000 in £500 shares. Objects: To acquire the patent rights (or some of them) of the Anglo-American Brush Electric Light Corporation, Limited, the Edison Electric Light Company, Limited, the Sellon and Volckmar's Electric Light Company, Limited, or of any other present or future company. Signatories (with one share each): H. Panmure Gordon, Hatton Court, E.C.; E. G. D. Gardner, 8, Finch Lane; C. Poston, 7, Drapers' Gardens, E.C.; S. Bustros, 58, Old Broad Street, E.C.; J. Lock, Stock Exchange; Philip Falk, 17, Great Winchester Street; and E. M. Hubbuck, 24, Lime Street. Registered 16th inst. by Michael Abrahams and Co., 8, Old Jewry.

* Signatories whose names are preceded by an asterisk are also directors.

NEW PATENTS—1882.

2192. "Bridges or loops for incandescent electric lamps." C. J. ALLPORT. Dated May 10.

2207. "Electro-magnetic and magneto-electric engines." C. F. VARLEY. Dated May 10.

2225. "An improved dynamo-electric machine." T. FLOYD and T. KIRKLAND. Dated May 11.

2226. "An improved incandescent lamp." T. FLOYD and J. PROBERT. Dated May 11.

2232. "Apparatus for generating electric currents." J. M. STUART. Dated May 11.

2233. "Electric lamps." J. M. STUART. Dated May 11.

2237. "Microphones." J. H. JOHNSON. (Communicated by A. D'Arsonval.) Dated May 11.

2248. "An improved apparatus for measuring electrical currents." T. VARLEY and H. B. GREENWOOD. Dated May 12.

2256. "Apparatus for regulating and directing electric light." H. WILDE. Dated May 13.

2259. "Apparatus for the transmission and reproduction of sounds by electricity." W. C. BARNEY. Dated May 13.

2263. "Secondary batteries." A. TRIBE. Dated May 13.

2270. "An improvement in the production and application of electricity for the purposes of lighting and of motive power and in the construction of incandescent lamps for use in connection therewith or otherwise." R. H. SIMONS. Dated May 15.

2286. "Electric lamps of the arc type." R. KENNEDY. Dated May 16.

2288. "Electric lamps." E. L. VOICE. Dated May 16.

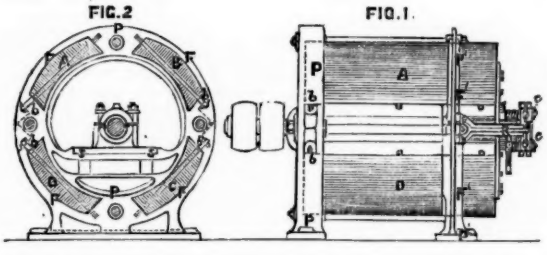
2293. "Improved means of insulating, covering, and coating wires used for electric lighting and telegraphic purposes." A. SHIPPEY and R. PUNSHON. Dated May 16.

2295. "Compensating dynamo-electric machines." B. H. CHAMEROY. Dated May 16.

2298. "Apparatus for operating sewing machines by electricity." W. R. LAKE. (Communicated by J. Kearney.) Dated May 16. (*Complete.*)

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1881.

4207. "Dynamo-electric machines." C. A. BARLOW. (A communication from abroad by Monsieur Auguste de Méritens, of Paris.) Dated September 29. 6d. Relates to magneto-electric machines, the object being to produce a powerful continuous current dynamo-electric machine, the inductors of which are composed of improved permanent magnets. Fig. 1 is a longitudinal elevation of the



improved machine, and fig. 2 is a cross-section of the same. This improved machine is composed of two magnetised clusters of horse-shoe form; each cluster has two arms (or branches), A, B, and C, D, formed of sixty-four plates; these arms are arranged in a circle inside which a ring rotates. Each of the sixty-four steel plates forming an arm is laid on a cylindrical surface formed in an opening, F^1, cast in an annular magnetic carrier, P^1, and in a recess, F, cast in a second annular magnet carrier, P. All the plates of each arm of the clusters are parallel, and they are pierced by three holes through which three straight bolts, *b*, *b*, *b*, are passed which clamp the sixty-four plates together. The magnet carrier, P^1, is of bronze, and the arms of the magnets pass through the openings, F^1. The second magnet carrier, P, is of cast iron; it forms the base plate (or magnetic yoke) common to all the clusters. One of the bolts, *b*, passing through the plate of each cluster serves to hold them together and against the inner side of the base plate. Iron projections insure magnetic contact of all the points of each arm with the base plate, P. The two magnet-carriers are connected together by four brass stays, and form the frame of the machine; bridges are cast on the magnet-carriers on which are fitted the pedestals, S, S^1, on which are the bearings of the driving-shaft. Outside the bronze magnet-carrier on the driving-shaft is a ring which contains sixteen bobbins, each composed of about eighty plates or other number of soft iron, about one-twenty-fifth of an inch thick, cut out so that each bobbin contains in itself four separate small bobbins. The sixteen large bobbins are fixed on to a bronze ring by bolts passing through projections on the ring. The sixty-four small bobbins are covered with suitable wire. The wire is left free where it enters and leaves each small bobbin to be connected to the plates of the collector which is mounted on the boss of the ring (and forms part of it). This combination has the advantage of allowing the ring and the collector to be separated or changed without taking the machine to pieces.

4304. "Dynamo machines for the production and distribution of electric currents." HECTOR AYLESBURY. Dated October 4. 6d. Consists chiefly in arranging systems or series of stationary field magnets with one or more systems of revolving magnets as to afford facility for producing a large number of currents for supplying a large number of electric lamps, or groups of electric lamps, and for coupling up any desired number of the field magnets, so as to produce stronger currents from any two or more of them, and thus overcome greater electrical resistance in any lamp or lamps, or *vice versa* detaching any desired number of these magnets if a smaller number or power of currents is needed.

4396. "Manufacture of carbons for electric lamps, &c." J. JAMES and J. C. F. LEE. Dated October 10. 2d. Relates to a process and apparatus for the manufacture of carbons for electric lamps in such a manner as to obtain great density and uniformity in their constitution. (*Provisional only.*)

4398. "Secondary batteries or electrical accumulators." A. W. L. REDDIE. (A communication from abroad by Ernest Volckmar, of Paris.) Dated October 10. 2d. The object of this invention is to render unnecessary the use in secondary batteries of a porous pot which creates useless resistance to the electric current, and to store in an apparatus of comparatively small weight and bulk considerable electric force. To this end two reticulated or perforated plates of lead of similar proportions are prepared, and their interstices are filled with granules or filaments of lead, by preference chemically pure. These plates are then submitted to pressure, and placed together, with strips of non-conducting material interposed between them, in a suitable vessel containing a bath of acidulated water. The plates being connected with wires from an electric generator are brought for a while under the action of the current, to peroxidise and reduce the whole of the finely divided lead exposed to the acidulated water. The secondary battery is then complete. (*Provisional only.*)

4405. "Producing the electric light, &c." A. M. CLARK. (A communication from abroad by Madame Josephine de Changy, née de Deyn, of Paris.) Dated October 10. 10d. Relates to improvements in electric lighting by the incandescence system in vacuo or otherwise, and it has for its object to render the carbon or other electrode incandescent without being traversed by the current in the direction of its length.

4507. "Insulators for telegraph wires, &c." A. E. GILBERT. Dated October 15. 2d. Has for its objects the more perfect insulation of the wire, the reduction of friction and abrasion at the points of suspension, improved facilities for attaching the wire to and detaching it from its supports, and economy in cost of construction and fixing. (*Provisional only.*)

4508. "Production, collection, or storage and distribution of electricity, &c." J. H. JOHNSON. (A communication from abroad by Ernest Ulysse Parod, of Paris.) Dated October 15. 4d. Relates to improvements in, or connected with, apparatus or means for the production, collection, or storage and distribution of electricity, and it consists in the employment, and in combination with condensing conductors, of accumulators or magazines of electricity, in order to collect and store up the electricity generated in excess. (*Provisional only.*)

4541. "Generation, collection, and distribution of electro-magnetic currents, &c." RANKIN KENNEDY. Dated October 18. 6d. Relates to improvements in the collection and distribution of electro-magnetic currents, and in the apparatus to be employed therein, and has for its main object to so collect and distribute the said currents that a number of separate currents may be collected and sent along one main line, and afterwards distributed in any order or combination to give variable and readily alterable powers and strengths of currents. It consists chiefly in fixing a number of armatures, with corresponding brushes, on one axle, and employing one set of inducing magnets.

1882.

834. "Electric lamps, &c." W. R. LAKE. (A communication from abroad by Bernard Lande, of New York.) Dated February 21. 6d. Relates to arc lamps, and has for its object to provide a simple and reliable feeding device, which is not liable to derangement, for raising the upper carbon to form the arcs between the points of the carbons, and to allow the said carbon to gradually move or be fed downward as the carbons are consumed. The said invention comprises two grooved pulleys fixed in yokes depending in brackets from the lower side of the electro-magnetic device, these grooved pulleys having the upper carbon rod between them, and being held in contact therewith by means of springs, which are so adjusted as regards strength or tension, that the carbon rod will fall down freely by its own weight, turning the pulleys as it descends, but will be held between the said pulleys when they are prevented from turning. Two brake-arms projecting downward from the moving core or armature of the electro-magnetic device partly surround the said grooved pulleys. These brake-arms are brought in contact with the pulleys when the moving core or armature first commences to rise, and so lock them by friction; and then the pulleys, with the carbon rod, move up with the moving core or armature to form the arc between the two carbon rods. As the carbons are consumed, the magnetic action of the current passing through the electro-magnet weakens the armature with the brake-arms, falls and releases the pulleys, and so allows them to turn, and the upper carbon to approach the lower one; this descent of the upper carbon is instantly arrested by the brake-arms when the arc is of normal length.

THE TELEPHONE CASE.

(*Continued from page* 352.)

Professor SILVANUS THOMPSON, *recalled.*

Examination-in-chief by Mr. PEARSON, *continued.*

PROFESSOR THOMPSON, in reply to Mr. Pearson, said that a loose contact and direct action of the sound waves is the essential feature of the microphone. Previous to the invention of the latter, no experimenter had employed direct action, tympans or diaphragms being always used. The microphone was decidedly a new discovery.

Cross-examined by Mr. ASTON.

The logograph of Barlow and the phonautograph of Leon Scott were, like Edison's phonograph, both calculated to record every sound. The records were faithful representations in each case. Edison was the first who used the record obtained for the purpose of transmitting. The piece of foil in the Hunnings transmitter could not be called a diaphragm.

Q. Can you give any definition of a diaphragm?—A. A diaphragm is something that separates something from something else.

Q. Then does not that sheet of foil separate the surface of the carbonaceous matter operated upon from the incoming waves of sound which proceed from your lips when you speak to it?—A. I have no doubt of it.

Q. Then that separating surface was extended all over the surface of the carbonaceous matter in the transmitter?—A. Yes; it is in Hunnings' always.

Q. Supposing it is intended only to act as an electrode, I suppose a strip of one-tenth part of an inch wide would answer all purposes for the purpose of transmitting electricity, would it not?—A. It would certainly.

Q. Therefore all the extent of surface that you have plus that strip is surface, that is either put there for nothing or put there for some purpose?—A. It is put there to prevent the coke tumbling up; it is the most convenient form of electrode for that purpose.

Q. A mere mechanical lid?—A. I regard it so, because I know, as matter of fact, in Hunnings' transmitter the side electrodes will work; the coke is liable to be tumbled out.

Q. Do you mean to tell my lord that the transmission of articulate speech would be as perfect if you take a heap of coke and speak to it as it is if you cover that coke over its entire surface with a metallic diaphragm?—A. It will be as perfectly articulate.

Q. You so mean to say?—A. I have heard it myself.

Mr. JUSTICE FRY: Have you ever taken the same instrument with a variation, except in the one case you have complete foil covering?—A. Not in a definite instrument.

Q. Have you taken that same instrument with that variation only?—A. I have taken a heap of putty with two small brass electrodes and laid them side by side, and a heap of coke upon them; I have removed one electrode and laid it on the top, so I have tried it in one sense in a certain kind of instrument—the experiment.

Q. Nothing could be simpler, I should imagine, than the definition of it—the other Hunnings with a piece of foil and the same Hunnings with a strip instead.

Mr. ASTON: The only instance in which you have made any experiment without the intervention of what I will now call on your definition a diaphragm, is the case that you speak of when you put the heap of carbonaceous matter upon a bed of putty?—A. Yes; I have tried it on two electrodes; not upon putty.

Q. When you had your bed of putty did you have it on a table?—A. I tried it both on a table and standing close up against the wall on the top of the mantelpiece.

Q. What kind of a mantelpiece was it?—A. A marble top one.

Q. And you spoke to the bed of putty upon the marble top mantelpiece?—A. I did.

Q. And do you mean to say you got articulate speech from the particles which you put upon the top of the putty?—A. Certainly.

Q. Faint?—A. Fairly loud.

Q. How close to the particles were you?—A. I tried various positions, talking close to, and talking up to a distance of eight or ten inches away.

Q. You gave us the statement with reference to the lampblack. That took myself and my friends with me rather by surprise. You stated lampblack was practically a non-conductor?—A. I certainly said so.

Q. That lampblack is practically a non-conductor, and in order to exemplify your statement you showed us a very interesting comparison between a rod of gas-coke and a tube filled with lampblack?—A. I did.

Q. Did you think it is a fair comparison to make, to take that stick of gas-coke and compare it as a conductor with lampblack loosely introduced into the glass tube?—A. I think it is perfectly fair, because I was comparing what one may call electrically equivalent rods of material.

Mr. JUSTICE FRY: Have you them here now?—A. I have not seen them this morning.

Mr. ASTON: Do you not know that by compressing your gas-coke you materially alter its conductivity?—A. I know that you do not alter its conductivity.

Q. You pledge yourself to that effect?—A. I pledge myself to the statement that you do not materially alter the conductivity of gas-coke by pressure.

Q. Do you alter its resistance to the passage of an electric current into and through it by compression?—A. You do not alter its specific electric resistance to pressure by any appreciable degree.

Mr. JUSTICE FRY: Are you speaking of one piece of coke?—A. I am speaking of a rod of gas-coke.

Do you apply the same to broken fragments?—A. No, simply because we had this question of interfaces coming in.

Q. You do not differ from the suggestion of the witnesses for the Plaintiff, that the pressure exerted upon the coke when broken up into faces, by increasing the interface, or by some other principle, does diminish the pressure and decrease conductivity?—A. On the contrary, I perfectly agree with it.

Q. Then what you are now addressing yourself to is pressure upon one system—as affecting the resistance through that piece of material?

Mr. ASTON: Let us eliminate your distinction, assuming that you had gas-coke instead of being in the condition in which it was in that rod, a condition in which you could get it into by powdering it and putting it into the tube, would you have the same resistance?—A. As in the solid lump?

Q. Yes.—A. Certainly not.

Mr. JUSTICE FRY: The resistance is increased by breaking up into small pieces?—A. Yes, because you have got a number of bad contacts throughout the face.

Q. Those are improved by pressure; the conductivity of the whole is increased?—A. Yes, I believe all scientific witnesses are now agreed on that point.

Professor Thompson considered that the change in resistance which took place in carbon under pressure was due to surface contact only. His own experiments proved this. The pressure only increased the area of the surface contact. Reiss's transmitter was intended by the inventor to work as a make-and-break contact instrument, and the inventor expected it to produce articulate speech by this action. As a matter of fact Reiss did obtain articulate sounds, but this was when the instrument worked in a manner which it was not intended it should. Professor Thompson was not aware that prior to Bell's patent anybody had written to the effect that Reiss's transmitter acted in any other way than as a make-and-break instrument. The witness had himself heard a Reiss instrument transmit articulate speech.

Professor AMOS EMERSON DOLBEAR, *sworn.*

Examined by Mr. HEMMING.

The witness considered that in the apparatus exhibited by Sir William Thomson at Glasgow the screw securing the iron plate was merely for the purpose of preventing the plate from being lost, and he thought that that would have been his opinion in 1876. If he had seen the instrument with the plate tilted up he would have thought that this had been caused by an accident. With the exception of the existing form of the Bell receiver having a permanent magnet, the latter instrument was identical with that exhibited by Sir William Thomson. The second Reiss receiver he considered acted precisely like the Bell. A tympan, witness described as a body which possesses elasticity either naturally, inherently, or else has it imposed on it by external conditions, such as would be in the case of a piece of membrane which is mounted at its edges and strained, or held by its edges in such a way that the maximum amplitude of vibrations shall take place at its middle point. That is a diaphragm in the sense in which it is used acoustically.

Mr. JUSTICE FRY: You say that is a diaphragm, not a tympan?—A. The tympan and diaphragm have, in some sort of way, become used interchangeably, but that is my definition of a tympan.

Q. You said diaphragm just now—you say they are the same?—A. Yes; the word diaphragm includes that and also another, a wider meaning.

Mr. HEMMING: If you have a limp substance and you want to make it into a tympan, in what way is it necessary to mount it?—A. It is necessary to mount it as a drumhead; that is, stretch it at its edges over some substance capable of resisting the same tension and keeping it taut.

Q. If you have a limp substance, you must stretch or strain it?—A. Stretch or strain—it should be strained. I should say still further, that in its vibratory properties, which will be now imposed on it, a new property has now been imposed—namely, that of vibrating at a certain rate per second, which it did not possess before.

Q. If you have a limp substance not strained, would you call that a tympan?—Not at all.

Hunnings' transmitter and Edison's transmitter Professor Dolbear considered acted in quite different ways.

Q. Now point out in what respect you consider them to be essentially different?—A. In the Edison transmitter what is first met with in front is the tympanum, or diaphragm, and against that is placed a piece of cork, or something that looks like it here, which I suppose underneath presses upon a metallic strip which is in contact with a so-called carbon button, which also is in contact on its other side with a strip of metal, and beyond that there is a screw, probably for adjusting. In this other instrument, which I will describe in the same order, there is, to start with, on the front side no tympanum, and nothing to take the place of what in the first instrument appears to be a piece of cork, and there is a piece of metal, which I suppose to be a piece of platinum—it looks like it—and underneath it is the powdered coke, and under that is a solid back.

Q. You call that a tympan, or a diaphragm in Edison; is that or not a tympan in the strict sense of the word in Edison?—A. It is.

Q. Having those other qualities you ascribe to a tympan when the word was used accurately.—A. Yes.

Mr. HEMMING: Now look at the Hunnings and tell me if you see anything which is, in the strict sense of the term, a tympan?—A. By the definition of the word tympan, as I gave it some time ago, there is no tympan there.

Q. You see that piece of platinum foil in the Hunnings?—A. Yes.

Q. You told us first, now, that every substance in the world would receive and repeat vibrations?—A. Yes.

Q. Having that in your mind, do you still say that the piece of platinum foil is not a tympan in the same sense in which you have

used the word?—A. In the same sense in which I used it before, I should exclude this from being a tympan, for the reason that it is damped over its whole surface by the material which it lies upon, and therefore the properties of a tympan are excluded from this.

Q. Will you look at that tinfoil in the Hunnings, and see whether you think it is meant to be strained?—A. It evidently is not strained, because, on touching it, I see that it will assume various forms and retain them—that is to say, the surface of it is not a uniform one, and it may receive any form of surface.

Mr. JUSTICE FRY: I suppose there is sufficient elasticity in it to recover its position after the vibrations produced by the voice?—A. When it vibrates by means of the voice it certainly will recover its position, but that may be due to the resiliency of the substance itself, or to the material that is underneath it, or to the air which will be compressed when it moves forward.

Q. By one or the other of those causes it does recover its *status quo ante*?—A. The same as any material—a door or anything else.

Mr. HEMMING: Let me put this. We have been told by the witness that if we had a substance that was perfectly limp, if there is such a thing—take a film of air—Sir William Thomson told us that that would move exactly in accordance with the vibrations of the air.—A. It would.

Q. You agree with that?—A. Yes.

Q. And, therefore, if you spoke to that after you ceased speaking, would it or would it not recover its position; the perfectly limp substance supposing you had a perfectly limp film in the air, and the sound-wave reaches it, it makes it move in accordance with the air; when the sound-wave ceases will that perfectly limp film come back to its old position?—A. It would.

Q. But if you had a substance perfectly limp like that, would that be capable of taking up vibrations in any way analogous to the action of a tympan?—A. No; it would not be comparable with a tympanum.

Q. Now, when you look at the action of that tinfoil, does not that limit the action of the tympan, or the action of this perfectly limp substance?—A. More likely the last.

Q. I will just ask you one other question. If you looked in the Edison to find something to which the Hunnings foil is analogous, what should you say it was?—A. A quite small piece of platinum, which is pressed tightly over all its surface by the cork which rests upon it.

Q. We have called that the electrode or conductor, that is a phrase that has been used?—A. I find a conductor pressed over its whole surface.

Q. And is the tinfoil in the other the analogue of that Edison's conductor or the analogue of Edison's tympan—which is it more analogous to?—A. It is more analogous to the former and not to the tympan.

Mr. JUSTICE FRY: You mean it performs the same functions, I suppose?—A. It performs the same functions.

Mr. HEMMING: That brings out what I wanted.

Mr. JUSTICE FRY: It performs the same functions as a foil—the foil in the Hunnings and the electric foil in the Edison perform the same function?—A. Yes; electrically the functions of the foil are the same.

Q. And acoustically the effect of their motions up and down is the same, is that so?—A. The motions are to and fro.

Q. In such case?—A. Yes.

Mr. HEMMING: You have compared the instruments with reference to the foil and the tympans—now as to the material: assuming the materials to be in the one case coke and in the other case lampblack powder, do you consider those to be essentially different, or essentially the same?—A. They are essentially different in the same sense as iron is different from platinum or any other metal.

Q. But, with reference to the work that they have to do, acting in a receiver, are they essentially the same thing or essentially different?—A. As far as the variation of the current strength of the electricity is concerned the functions would be the same, but so far as the physical action which takes place in them is concerned they are different.

Q. What is the most important distinction between them in that respect—between the gas-coke and the lampblack?—A. In the case of the lampblack, the lampblack, as I said a little time ago, is a substance almost or wholly void of elasticity, and therefore the elasticity has to be provided for in some way because it is essential. It is provided for in this case by making it tolerably dense by compression to begin with, and then fastening it in a chamber which holds it snug and tight about its edges, both front and back, and subjecting it to pressure from behind and also from the front, which comes from the elasticity of the tympan, first; but, secondly, there is another element which comes in here which I find is one of the proper conditions for this, namely: lampblack, when compressed in this way, absorbs a quantity of air and other gases which it may have in its neighbourhood, and by just as much of that air or other gas as has been absorbed by it it becomes elastic through the absorption of that, and any pressure that is superposed upon the lampblack in that way will enable the whole button of lampblack to recover its former volume through the elasticity of the air which is in it—in a measure.

Mr. JUSTICE FRY: So that in the result the heap of coke is elastic and the button of lampblack is elastic—the one by its inherent elasticity, the other by what I may call its adventitious elasticity?—A. It is like that.

Mr. HEMMING: Now, as to lampblack in powder, would you say the same as to that? Is that elastic or not?—A. Lampblack in powder is not elastic.

Q. There is another matter that been gone into which I should like to ask you one or two questions about. If you have, we will say, no foil between the air-waves and the material operated upon, in what way do you consider that the air-waves would operate upon a heap of broken-up coke?—A. It would operate in two ways, depending upon the direction in which the vibrations in the air impinge on it. In the first case the sound vibrations impinging upon it were vertical to the surface, in that case the condensations of the air would at first tend to make the particles of coke to approach each other, and the refractions in the air would cause it to recede; because the pressure within the body would be greater than it would be without. If, on the other hand, the vibrations should meet such a body as that at some other angle, then we might have the conditions in which the condensation of air was in the gas-coke result in separating them instead of forcing them together, and in that case the electrical effect would be exactly the opposite of what it would be in the first, namely, the current of electricity, which in the first place would be increased by the condensation, would be decreased by that same condensation.

Q. That is how it would work with gas-coke?—A. With gas-coke; but with lampblack it would not be so, because the air-waves could not get through it in the sense in which they could get through the coke. It is substantially a solid substance when compressed in the form which is used here.

Q. Now I have put the case to you, first, speaking of a heap of this material without any foil or diaphragm of any kind over it; suppose, now, I alter the conditions a little, and put over it a foil, if you can get it, which was absolutely and perfectly limp in the theoretical sense in which we have been speaking—an absolutely and perfectly limp foil—with no elasticity over your heap, how would the air act on that heap of gas-coke in that case?—A. Am I to suppose that this first foil is quite impervious to air-waves, or that they would go through as they would go through a piece of cloth?

Q. Take it either way—whichever way you please. We will have both ways.—A. Supposing that the first substance was pervious, then it might as well be left off; it would be just as if it were not there at all; it would be just as I described it at first; but if, on the other hand, it was impervious to air, then the air-waves would compel the particles of coke to approach each other, and therefore there would be a decrease of resistance instead of an increase.

Q. Suppose this, I am taking a perfectly limp diaphragm?—A. That is what I understood.

Q. You have an air-wave on one side that you have told us will make the diaphragm move—slightly at all events—how will the air move on the further side of that limp diaphragm? will it move in the same way as if there were no limp diaphragm, or in a different way?—A. In the same way.

Q. In the same way as if there were no diaphragm there at all. Coming back to our first experiment we will have a perfectly limp diaphragm over our heap of gas-coke; how will the air in the interstices of the gas carbon move when you have got the limp diaphragm over the coke? will it be in the same way as if the limp diaphragm were not there, or in a different way?—A. Substantially in the same way.

Mr. JUSTICE FRY: The limpness makes the diaphragm move exactly as the air would move without it?—A. Precisely so; and that I should like to say is not due to anything except the physical conditions which are involved in it, and which are patent to the universe, for the reason that man does not impose them, but simply finds them—that is to say, they are the conditions under which sound is propagated under all circumstances.

Q. I suppose a stratum of air is a limp diaphragm?—A. Yes; a typical one.

Mr. HEMMING: Now, looking at the Hunnings instrument, from the construction of that instrument would you say that its principle was in any way altered if instead of that foil you had got a perfect conductor which was also perfectly limp—would that alter the construction of Hunnings in the least?—A. I do not think it would.

Q. And looking at the instrument itself, can you say from the construction of the instrument whether it is reasonable to say that that piece of foil was put in to act as a limp conductor would act, or that it was put in to act as a tympan would act—does the construction of the instrument enable you to answer that question?—A. The construction of the instrument would enable me to infer that the purpose of that front electrode was to perform two functions, namely, to prevent the loss of the material when the instrument moved; and, secondly, to form a suitable electrical connection in the interior material; and it has not the special functions as an air-wave receiver.

Q. It would perform those two functions if it were perfectly limp, I suppose?—A. Yes, precisely.

Dr. WILLIAM HENRY STONE, *sworn*.

Examined by Mr. GOODEVE.

Witness defined a tympanum as a disc or diaphragm of a more or less elastic material fixed round the edges, or strained round the edges, and which vibrates by regular vibrations to certain notes of the harmonics of those notes. The piece of foil in the Hunnings transmitter he would rather call an electrode than a vibrator. It is essential to the action of a tympan that it should only be touching any substance at the edges of the extreme circumference and at the centre. Although witness originally thought that Reiss's apparatus worked by intermittent contact, he did not think so now.

Professor WILLIAM FLETCHER BARRETT, *sworn*.

Examined by Mr. PEARSON.

Witness had seen the apparatus exhibited by Sir William Thomson at Glasgow, and had drawn the receiver with the plate tilted up. He had constructed a receiver in the autumn of 1876 which reproduced articulate speech perfectly. This instrument was an imitation of Reiss's second receiver. Reiss, the witness thought, did not fully understand his own apparatus. The only new portions on Bell's receiver appear to be the permanent magnet and the iron plate. Reiss, in his German paper, mentions the transmission of speech, and how speech could only be transmitted; he also mentions that his apparatus will transmit compound tones.

In the case of the Hunnings transmitter the waves of sound are

distributed more over the platinum foil than they are when they are brought down through the tympan to the centre, as in the Edison apparatus, the result being that in the latter the sibilants are missed. Hunnings' transmitter, the witness considered, was a microphone pure and simple ; the platinum foil he did not consider to be a tympan.

Q. Did you try coke particles sprinkled on a gridiron, a wire electrode embedded in putty?—A. Yes, this is an experiment with the object of ascertaining whether speech could be transmitted without anything resembling a tympan—even using the word in the most liberal sense. I bedded in putty a series of copper wires, and by the side of them another set of copper wires, making them together into a gridiron, fastening the whole firmly down and sprinkling on the top some of this Hunnings' powdered gas-coke. I then spoke to this arrangement and an assistant in a different room listened to the telephone and told me he heard. Then we changed places, and I heard him, so that speech could be transmitted with perfect distinctness by this arrangement. I may add that I supported the base of this on three little nobs of putty to insulate it as far as possible from the table on which the whole thing rested.

Q. Did you try coke particles or cinders on a gridiron electrode, mounted on a thick plate of glass?—A. Yes, that is very much the same thing.

Q. I will take another one, did you try semicircular electrodes resembling a ring cut in halves and embedded in putty?—A. I did, here is the arrangement, a metal ring cut in halves and bedded in putty, and the outer portion of the ring carefully covered over with putty in that manner (*describing*), then the particles of gas-coke sprinkled between and speaking directly upon it. A telephone can be attached to the other end. Speech was perfectly transmitted.

Q. Did you try similar electrodes mounted in a case, coke particles being contained within horn or muslin?—A. I did.

Mr. JUSTICE FRY: You put in the second?

Mr. PEARSON: I put them all in.

Mr. JUSTICE FRY: No, the Professor has withdrawn one or two.

Mr. PEARSON: I put in those two putty instruments before your officer and this one.

Q. Will you explain this one to my lord?—A. I had the following arrangement made. I had a diagram made of this. It is a ring of brass, very like the electrode on the putty, mounted in an ebonite case, and a sheet of horn placed in front, and another sheet of horn placed behind; between the two, which are one-quarter or one-eighth of an inch thick, the coke is placed, and speaking on this the speech was transmitted with marvellous fidelity and loudness. Here the electrodes are at right angles to the direction of the sound-waves, at right angles to the ordinary direction. Then pinching the horn on each side with the fingers, so as to stop any tympanic action possible, still speech was transmitted. Putting two little cocks in the centre of each horn-electrode, and screwing it up tightly in a vice, and then speaking to it, still speech was transmitted, only more faintly—the particles were then being squeezed too tightly together. Then I removed the horn and placed muslin, everything else being exactly the same. With this arrangement the most admirable transmission of speech was obtained. I do not know that any one can wish for a better transmitter than a pair of muslin surfaces with gas-coke between an electrode, and solid plates of glass bedded in the ebonite case.

Mr. JUSTICE FRY: Do you put those in?

Mr. PEARSON: Yes?—A. As it might be urged possibly that some tympanic action reached the electrodes through the ebonite case, I removed the semicircular piece of brass, and hung down two strips of this platinum foil, attached to the one end only—here is the one strip attached to the one binding screw, and the other strip attached to the other binding screw, fixed only at one end, and speaking into this, also, the most beautiful transmission of speech was obtained, the electrodes in no sense being attached to the horn-sheathing here, quite free, as you can see, shaping about. Perhaps the most beautiful that I have ever obtained was by using gelatine sides, arranged in the same way as the horn. Here it is. (*The instrument was handed to his lordship.*) It can be put on to the instrument in the other room—we have a wire in the room, I believe.

Mr. JUSTICE FRY: This is coke included between two gelatine surfaces?—A. Yes, and the electrodes fixed round the sides.

Q. Have you tried what seems to me to be the principal thing in this inquiry? Take a Hunnings transmitter, take away the platinum foil and put a piece of wire in its place—have the question of the plate isolated from all the other matters?—A. That is another experiment that I am going to describe. I perhaps may mention that with this instrument, I think, it was the first time I heard such words as "whim," "hiss," and "kiss" transmitted with absolute fidelity, in the little gelatine instrument.

Q. I suppose that would make it a popular instrument?—A. Here I have the one numbered 10. I remove the upper electrodes from the Hunnings, and in its place put the thinnest piece of foil that I can get—the thinnest in the world. I do not know whether it was silver-foil or tinfoil, but it was exceedingly thin. I then slashed it across with my penknife—the upper eclectrode. I tried goldleaf in the first instance, but that was too thin, it broke through it.

Q. And you removed the mouthpiece to its original position?—A. Yes.

Q. Therefore the conditions were exactly the same except that the substitution of what I may call a wire for a disc——?

Mr. WEBSTER: A slashed piece——?

Mr. JUSTICE FRY: He said the narrowest piece in the world.

Mr. WEBSTER: The thinnest?—A. The thinnest.

Mr. JUSTICE FRY: Why did you not take a mere piece of wire?—A. I have done so.

Q. This is not it?—A. I take it they were all wires——

Q. You have got before you a means of isolating this inquiry from any difficulty created by difference of instruments.—A. If you use a simple wire in the place of the surface, you will have a current passing from the higher down to the lower electrode, and you will enormously increase the resistance.

Q. In fact it would operate in the same way as a mere electrode?—A. I take it as a mere electrode.

Q. A thin wire is a form of electrode?—A. Certainly it is.

Q. If the plate has no operation, then I should have thought the simplest thing was to take away the platinum foil, and put in the narrowest thing in the world?—A. Take another instance; if in the case of the water instrument, if you were to attempt to decompose the water with thin platinum wires it would be decomposed with extreme slowness, but if you were to take wide electrodes it would be decomposed with more freedom. It is simply the case of a freer current.

Q. The Hunnings will not work without the platinum foil?—A. This is a silver foil. There is another experiment with two strips of brass; that works perfectly. There are two strips of brass placed above one another, and speaking to that the speech will operate the transmitter.

Mr. JUSTICE FRY: You have not the same conditions as you have in the Hunnings; you have varied it. In a matter of this sort where there is so much ignorance, it is desirable to isolate the inquiry from all possible variations produced by change of conditions?—A. My object is as far as possible to get rid of tympanic action.

Q. I should have thought that the best way to do that would be to do away with the tympan—the plate?—A. In this case I have done it (*referring to an instrument*).

Q. Is that a Hunnings?—A. Yes; instead of one electrode being below and the other electrode being above, the two are placed side by side. Those particles cannot be hung up in the air alone, they must be supported in some way. I varied the experiments in every conceivable way.

(*To be continued.*)

JUDGMENT.

Injunction granted with costs as regards Hickley's and also Cox-Walker's receivers.

The portion of the case referring to the transmitter dismissed with costs, Edison's patent not being upheld.

CITY NOTES.

OLD BROAD STREET.

THE BRAZILIAN SUBMARINE TELEGRAPH COMPANY (LIMITED).

UNDER the presidency of Sir James Anderson (vice-chairman of the company), the seventeenth half-yearly general meeting of the above company was held at Cannon Street Hotel, on Friday, the 12th instant.

The Secretary, Mr. Richard Collett, having read the notice convening the meeting, and the minutes of the previous meeting having been likewise read and approved, the Chairman said: Will you take the report (*see* THE ELECTRICAL REVIEW, May 6th) as read, as it has been in your hands sometime? ("Agreed.") I have very few remarks to make. I must first apologise for the small number of directors who are present to-day. Lord Monck, as Lord Lieutenant of the County of Dublin, cannot leave his post, owing to the late calamity, and Sir Thomas Fairbairn is summoned to a committee in the House of Commons at two o'clock to-day. You will have to take the few present as representing your interests. As to the condition of our cable, we had a fault at the Pernambuco end when we last met you, but the fault was so minute that we were not sure whether it was at the other end, or at sea in deep water. We sent a vessel out to remove the part, and she found the cable seaward of her all the way to St. Vincent in as good, or even better condition, electrically, than when first laid; but at the shore end, for eight miles from the shore, we find we must renew the cable. It will cost us something like £5,000 to do so, as it is a heavy class of cable. I am, I may say, directly or indirectly associated with all the telegraph companies, and I know of no company which has been more free from expense than this, or where you will find so little money expended in repairs as by this company; it has had singular immunity from interruptions, and is the envy of every telegraph company in the world. The next thing I have to refer to is our traffic. For the last half-year there has been an increase of £675 over the preceding half-year. Each half-year in all companies is of different value; that is to say, there is one half-year of considerable value, and in the other half the traffic comes down. Comparing the past half-year with the corresponding period of 1880, there is an increase of £4,600, and there is an increase from the 1st of January of £3,060; in the working expenses there is a decrease of £243. Before I sit down, I have to speak of the resignation of our director in Brazil, Mr. de Andrade Pinto, who has joined the Ministry, and I have no doubt the new appointment we are about to make, in accordance with our articles, will meet with the approval of the shareholders. I am happy to say we have a very good man, who has acted as our solicitor out there, to represent us. There is always, you are aware, an amount of correspondence between here, Portugal, and Brazil, and I think we are very fortunate, especially, in having Mr. Santos Silva at Lisbon, and I have no doubt we shall prove equally fortunate in the new appointment in Brazil. I may make one remark in reference to Mr. Jay Gould's opposition. We only know that Mr. Jay Gould has got a concession to lay a cable from Brazil to North America. Whether he will lay it or not, I do not know. If he does lay the cable it may be a matter of competition; we have so much in favour on our part, that I do not regard the opposition as serious at all. I should not sell a share on that account. I do not know that I have